Pile-and-Mat Foundation for Power House in Marsh

SYNOPSIS—To carry Essex Station on Passaic River marsh, the full area had to be piled at minimum spacing. Unreinforced-concrete mat caps the piles; pile-heads peeled where surrounded by concrete.

A difficult foundation problem was presented at the Essex power station, a large new generating station which the Public Service Electric Co., Newark, N. J., is building on the bank of the Passaic River in the extreme southeast of the city, in the tidal marsh of Newark Bay. The soil is very soft, peaty and alluvial marsh ground to a depth of about 35 ft., to which depth the foundation necessarily had to go. Piles were the logical solution. But with very heavy concentrations of load it seemed impracticable to provide isolated pile groups. Apart from the cost of the footings, the weight of the station is very large—approximately 2 tons average weight per square foot over the entire area, but by no means uniformly distributed—so that sufficient pile capacity could be obtained only by covering the whole area with piling.

Under these conditions recourse was had to a concrete slab or mat over the whole site, supported by piles driven

FIGS. 1 TO 3. FOUNDING A LARGE ELECTRIC POWER STATION ON SOFT MARSH

Upper view—Original condition, August, 1914. Lower views—A section of piled ground inside of coffer-dam, and the finished boiler-house foundation

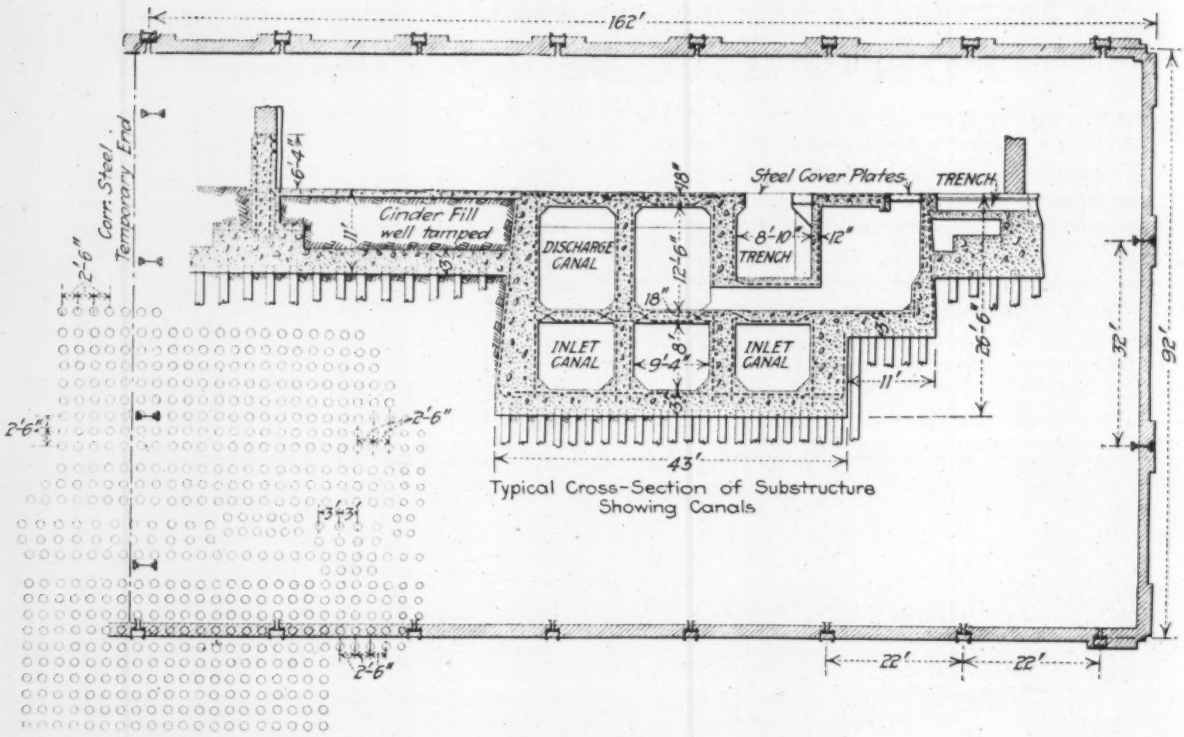


FIG. 4. DETAILS OF TURBINE-HOUSE FOUNDATION FOR ESSEX POWER STATION NEAR NEWARK, N. J.

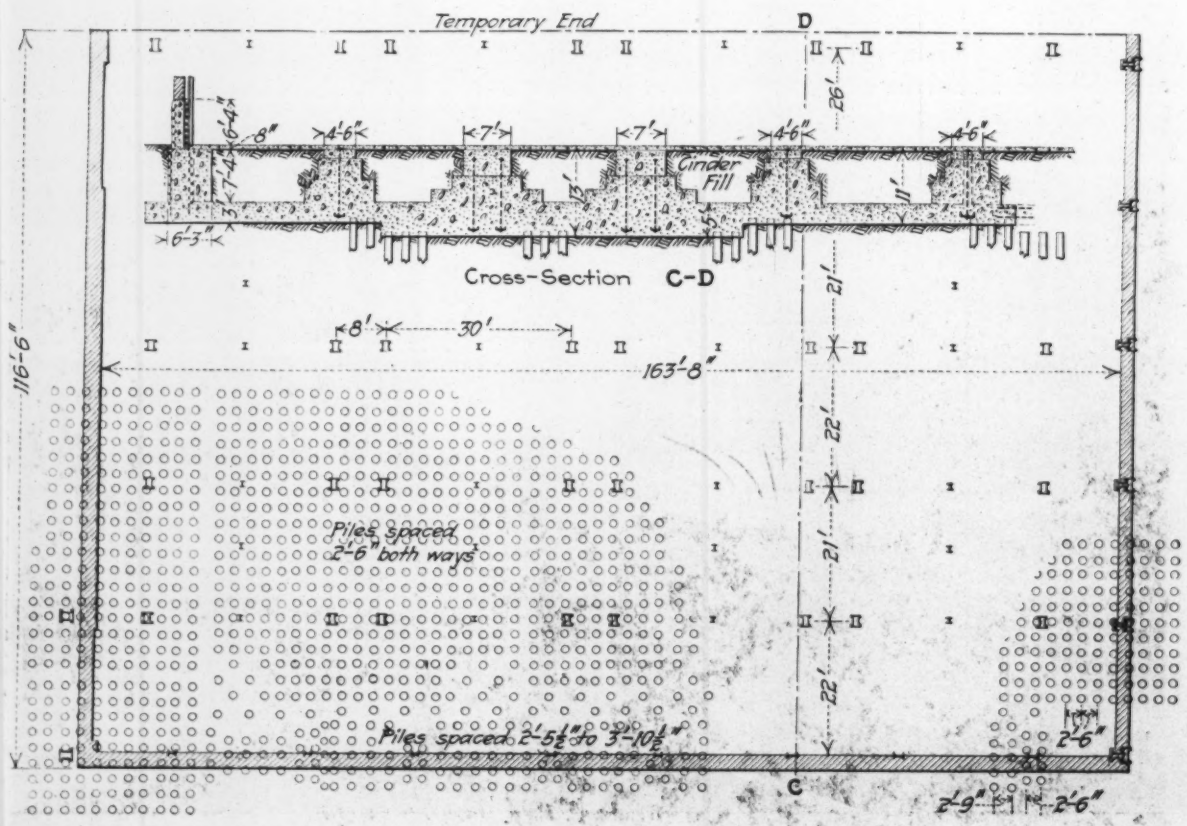


FIG. 5. BOILER-HOUSE PILING AND FOUNDATION MAT, ESSEX STATION

all over at substantially minimum spacing. There is no steel reinforcement in the mat of the boiler house or turbine room (except under the canals). In the switch house the 15-in. mat between column piers is reinforced and has no piles under it. The latter arrangement was selected, as the column loading did not require piles over the whole area, and the 15-in. mat ties the structure together, as

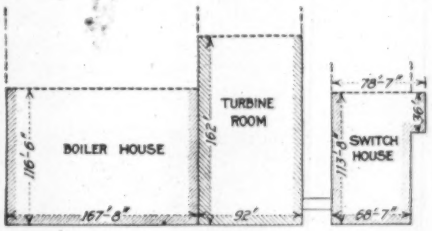


FIG. 6. KEY PLAN OF PLANT

there is a complete system of piling around and under the outside walls.

The boiler-house and turbine-house foundations, with complete piling and with uniform mat on which are supported stepped footings and piers for the columns, are shown in Figs. 4 and 5.

Piles are spaced 30 in. on centers, minimum spacing; there are about 9,000 in all under the entire group of buildings. They were driven after excavating to below low water behind a pile-and-earth bulkhead coffer-dam. The space between piles was refilled with cinders and earth to the desired bottom of the mat, 9 in. below cutoff. The tops of the piles were then peeled to give a clean contact with the mat concrete.

The mat in the boiler house is 36 in. thick, thickened under the stack columns up to 5 ft. in order to distribute the load over the required number of piles, but maintaining a uniform elevation of bottom over the remaining area. Thus there is ordinarily 27 in. of concrete over the pile tops except under the stable columns.

The concrete was placed in sections about 20 to 40 ft. square, as conditions permitted. No attempt was made to form vertical construction joints. A single curb timber of 6x6 was placed along the free edge of a section, its top flush with the intended top of the concrete, while below this curb the concrete was allowed to taper off outward at its own slope. Thus a long flat-sloping bond surface was produced, with a 6-in. rabbet or gain at its upper edge. The latter feature avoided the formation of a feather-edge joint on the surface of the mat.

The top of the mat is 7½ ft. below the column bases. Concrete piers are built on it to support the bases. Under several rows of columns in the turbine house and the switch house these piers are connected to form a continuous wall, which assists in the load distribution. Concrete floor surfacing will be laid on a cinder fill placed between walls and piers.

The Essex station was planned and designed by the engineering organization of the company, under N. A. Carle, Chief Engineer, Linde & Griffith, of Newark, N. J., were the contractors for the foundation.

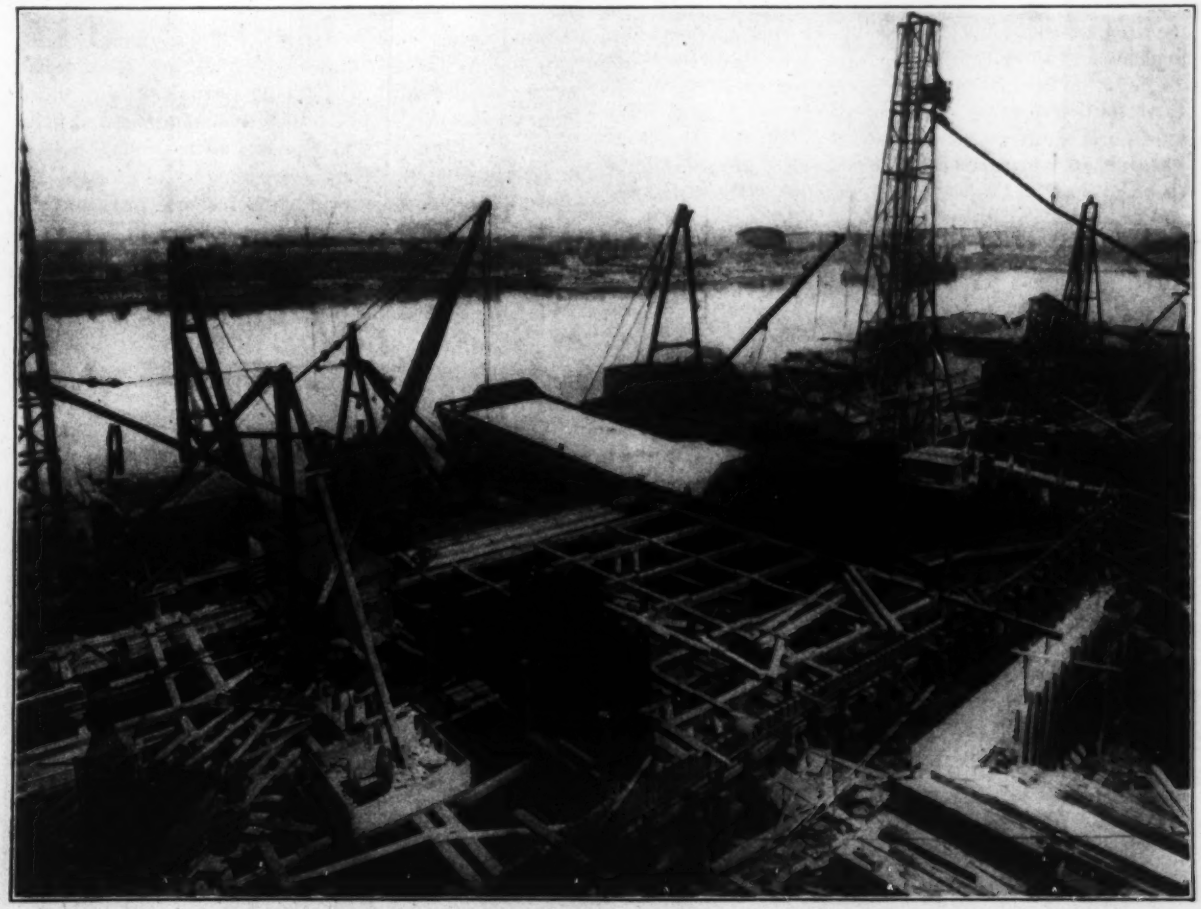


FIG. 7. FOUNDATION CONSTRUCTION PLANT ON ESSEX STATION (VIEW TOWARD TUNNEL FOUNDATIONS, MAY 11, 1915)

New Methods in Building Concrete Cottages

By C. E. Drayer*

A development of experimental work continued over a number of months is represented in the building of the concrete cottages shown in Figs. 1 and 2. D. S. Humphrey, of the Humphrey Co., owner of Euclid Beach Park, a summer resort on the Lake Erie shore near Cleveland, Ohio, was the chief factor in the development. He originated the concrete conveyor (Fig. 5), which is one of the striking features of the work. This is a distinct innovation in concreting methods.

The motive was the demand for summer cottages at a reasonable rent, but with modern conveniences, which required a durable but low-cost type of construction. The final answer, after considering various methods of building, was the monolithic poured-concrete house.

At first several concrete cottages with sloping roofs were put up. It was found, however, that the pitch roof was difficult and expensive to build and more difficult to keep in shape. Cracks would develop. Then the flat roof with earth covering was hit upon, and it has proved satisfactory.

The foundation of the cottage is a reinforced-concrete slab resting on the surface of the ground, which serves as a floor. Walls, partitions and roof are of reinforced concrete 4 in. thick. A parapet is built above the roof, partly to give a finished appearance, but also to retain the earth which is spread over the roof to keep off the sun's rays.

After the general shape of the cottage was worked out there was need to find a form which would allow full control of placing the concrete in the narrow walls. There was also need to devise a method of mixing and conveying for continuous supply of concrete of the proper consistency.

Wood forms had been tried, but were unsatisfactory both because of the difficulty in placing concrete and because of the expense of taking them down and setting them up again. A set of steel forms manufactured by the Hydraulic Pressed Steel Co. was then tried and found to be satisfactory. They are composed of pressed steel studs, with removable form plates fastened to them by U-clamps. In Fig. 3 all studding except that of the parapet

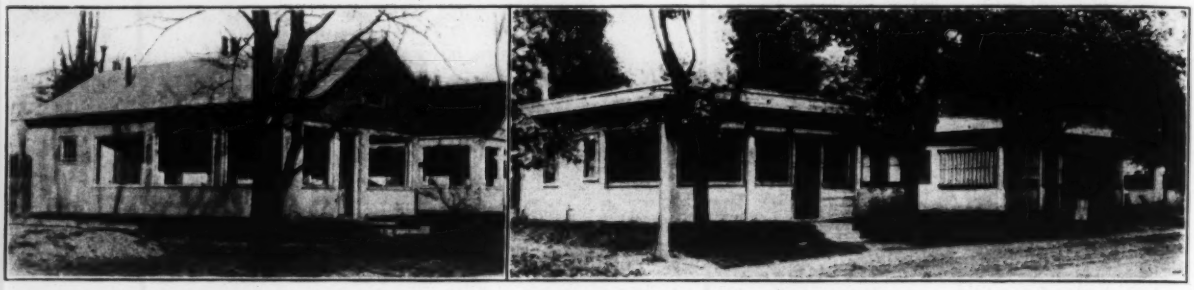


Fig. 1—Early design, with pitch roof

Fig. 2—Final design, earth fill on flat roof

FIGS. 1 AND 2. CONCRETE COTTAGES AT EUCLID BEACH, A SUMMER RESORT NEAR CLEVELAND, OHIO
Designed to meet demand for low-cost durable beach cottages

FIG. 3. STEEL STUDS AND PART OF FORMS FOR CONCRETE COTTAGE

*1801 East 93rd St., Cleveland, Ohio.

is in place, with a few of the form boards attached. These forms consist of 1¾-in. tongued-and-grooved boards, with a pressed-steel plate on the face toward the concrete. The forms are held securely to the studs by wedge clamps, which are tightened with a hammer. Bolts fitting into keyhole slots in the backs of the studs hold the clamps securely in place.

The concrete is mixed by a continuous mixer, which discharges into a trough-shaped conveyor inclined upward and leading to a hopper above the roof of the cottage. A sprocket chain with steel scraper blades attached pushes the concrete up the conveyor trough into the hopper, from which a spout distributes the concrete to the forms. By swinging the conveyor and the spout, concrete is placed anywhere in the building. Mixer and conveyor are run by a small gasoline engine. About 4 hr. is required to pour one cottage, which contains about 50 cu.yd. concrete. A typical cottage is 35x21 ft., according to the plan, Fig. 4.

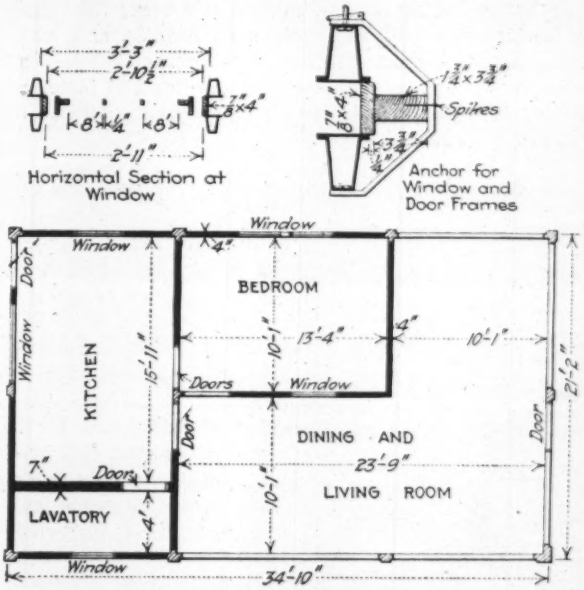


FIG. 4. CONCRETE COTTAGE BUILT WITH PRESSED STEEL FORMS

The interior face of the concrete is rubbed as soon as the forms are removed and later painted with a concrete paint. The exterior is bush-hammered, except the trim, which is rubbed till a smooth surface is gained.

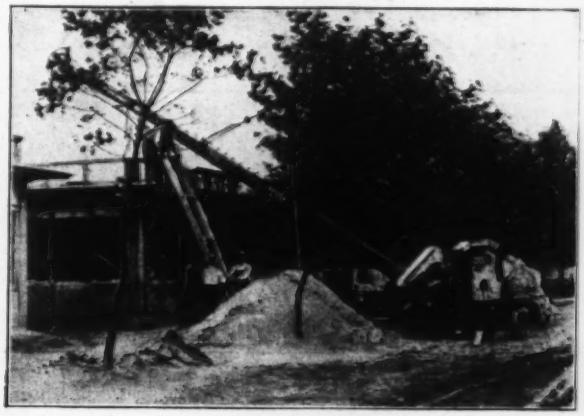


FIG. 5. RAISING CONCRETE TO FORMS BY SCRAPER CONVEYOR FROM CONCRETE MIXER

The cost of the forms must be distributed over about 50 cottages in order that the part borne by each may be low enough to make them economical. It is expected that, with a gang working continuously, the concrete cottage with plumbing, electric wiring, screens, awnings, etc., can be built for about $600 under this community system, where a great number of similar buildings are built in the same locality.

Use of Electricity in North American Cities

An interesting table showing the per-capita consumption of electric power in Winnipeg as compared with other large cities in Canada and the United States has been made by H. E. M. Kensit, of the Dominion Water Power Branch, in connection with a study of power questions in western Canada. Only 20 cities were covered, as sufficiently complete data were not returned in response to inquiries of a larger list.

The high per-capita figures for power consumption in Winnipeg are due to the low cost of electricity and the high cost of coal and gas.

The quoted figures are given as only approximate, although believed to be substantially correct. Care was taken to cover all sources of public electric supply for each city, including street and elevated railways. In each case the load and output for the city and district are taken, but the population shown in the accompanying table is the estimated 1914 figure within the city limits.

ELECTRIC CENTRAL-STATION LOADS IN AMERICAN AND CANADIAN CITIES, 1914

	Estimated Population, 1914	Connected Load, Kw. Total	Connected Load, Kw. Per Capita	Peak Load, Kw. Total	Peak Load, Kw. Per Capita	Output, Kw.-Hr. Generated Total	Output, Kw.-Hr. Generated Per Capita	Figures Include
Atlanta, Ga.	199,740	88,000	0.440	44,320	0.222	145,684,803	730	Georgia Ry. & Pwr. Co.
Buffalo, N. Y.	457,900	137,872	0.310	67,424	0.147	302,220,107	660	Buffalo Gen. Elec. Co.; Cataract Pwr. & Condt. Co.
Chicago, Ill.	2,436,000	852,000	0.350	344,500	0.142	1,280,962,600	527	Commonwealth Edn. Co.; Str. Ry. Cos.; Sanitary Dist.
Columbus, Ohio	213,900	49,309	0.230	19,471	0.091	70,283,250	329	Columbus Ry., Pwr. & Lgt. Co.; Muncpl. Dept.
Detroit, Mich.	583,000	.....	.....	87,800	0.150	329,395,900	565	Edn. Illuminating Co.; Muncpl. Dept.
Louisville, Ky.	232,350	97,000	0.417	28,200	0.122	100,692,219	433	Louisville Gas & Elec. Co.; Str. Rys.
Milwaukee, Wis.	420,000	.....	.....	46,924	0.112	170,889,000	406	Wisconsin Edn. Co.; Commonwealth Pwr. Co.
Minneapolis and St. Paul	601,900	144,778	0.240	91,655	0.152	270,168,475	450	Minneapolis Gen. Elec. Co.; Consumers Pwr. Co.; Twin City Rapid Trans. Co.
Nashville and Chattanooga	179,590	60,843	0.338	20,200	0.113	71,401,500	398	Nashville Ry. & Lgt. Co.
Philadelphia	1,671,000	202,086	0.121	82,078	0.490	275,711,745	165	Phil. Elec. Co.; Str. Rys.
Pittsburgh	572,700	.....	.....	71,000	0.124	316,500,000	553	Duquesne Lgt. Co.; Penn. Lgt. & Pwr. Co.
Portland, Ore.	314,000	.....	.....	47,775	0.152	199,166,000	634	Portland Ry. Lgt. & Pwr. Co.; N. W. Elec. Co.
Providence, R. I.	249,000	82,060	0.330	39,700	0.160	113,286,600	455	Narragansett Elec. Lgt. Co.; Rhode Island Co.
Rochester, N. Y.	248,000	68,177	0.274	29,813	0.120	123,850,785	500	Rochester Ry. & Lgt. Co.
St. Louis, Mo.	740,400	.....	.....	92,176	0.125	319,151,753	430	Union Elec. Lgt. & Pwr. Co.; Elec. Co. of Mo.; United Rys. Co.; Laclede Gas Lgt. Co.
Toledo, Ohio	187,250	60,315	0.322	23,965	0.128	91,996,426	491	Toledo Rys. & Lgt. Co.
Montreal, Que.	570,500	222,000	0.384	65,000	0.113	300,000,000	520	Montreal Lgt., Heat & Pwr. Co.
Toronto, Ont.	468,000	178,677	0.382	64,064	0.137	250,240,500	535	Elec. Lgt. Co.; St. Ry. Co.; Ont. Hydro-Electric System.
Vancouver, B. C.	186,400	61,290	0.330	34,300	0.184	124,884,565	668	B. C. Elec. Trac. Co.
Winnipeg, Man.	226,000	136,000	0.600	43,300	0.191	167,765,000	740	Winnipeg Elec. Ry. Co.; City Lgt. & Pwr. Dept.

Halifax Ocean Terminals

SYNOPSIS—Largest harbor work now in progress in North America. Contracts let total $7,000,000. Project to cost $30,000,000. Involves 6 mi. of new railway through virgin territory, 2,000-ft. landing quay, six piers and berths, all in deep water; complete railway and wharf intercommunication and modern freight equipment. Remarkable quay-wall construction of 60-ton concrete blocks stacked up to make 60-ft. wall.

The Dominion of Canada through its Department of Railways and Canals is now engaged at Halifax, Nova Scotia, in the construction of one of the largest port developments in the world—a development which comprises not only an entirely new location of the ocean terminals of a port now over 150 yr. old but also the radical revision of the railway entrance to the city. The scheme is of much more than local or even provincial importance, inasmuch as it is part of the transcontinental railway enlargements fathered by the Dominion Government and a bid for the transatlantic trade centering not only around interior Canada but the great northwest section of the United States. Started in 1913, it has been consistently carried forward even during the financial stress of the past year and has now reached a substantial advance in actual construction. Contracts already let total over $7,000,000. It is estimated that the finished scheme will cost four times that amount. The city of Halifax, the largest city in Nova Scotia, is located on the east coast of that peninsula, in a harbor of exceptional natural advantages. Direct passage is offered ocean steamers from the open sea through a wide bay entrance to deep-water berths protected by islands and promontories from the force of wind and waves and faced by a basin of ample space for manœuvering. Although quite far north, it is ice-free the year round. Furthermore, it is the port in North America nearest to Europe. Its location on the continent is not so advantageous, inasmuch as while it is on the Nova Scotia peninsula, "the long wharf of Canada," all railway connections must go north to the neck of that peninsula to reach the mainland. It has, however, an old-established railway which is tied up to the various Canadian transcontinental lines.

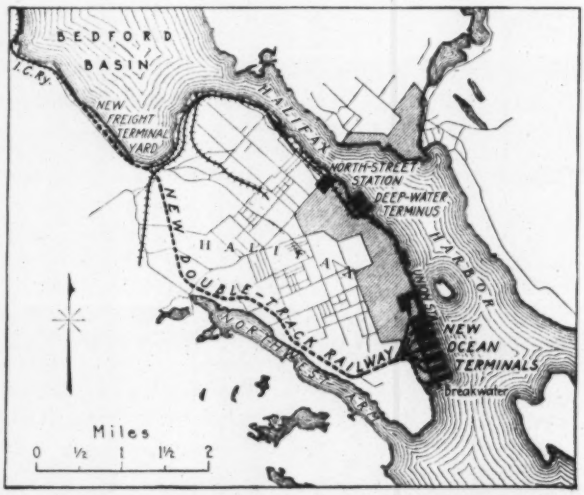


FIG. 1. MAP OF HALIFAX, NOVA SCOTIA, SHOWING LOCATION OF THE NEW DEEP-WATER TERMINALS

The city was founded in 1759 and had only a provincial importance until the beginning of the railway era, when for a time it promised to monopolize the trade of eastern Canada. The more orderly development of other Atlantic and St. Lawrence ports, and particularly their greater attention to transshipment and transportation necessities, soon caused them to surpass Halifax, and for many years it progressed but little as a port.

The defect at Halifax lay in poor railway connections, and more especially in inadequate and faultily located terminals. The main part of the city is situated on the east shore, about midway down a peninsula about 5 mi. long and 2 mi. broad, making out into the bay. This peninsula, particularly the northern section, rises rather abruptly from the shore, the rise continuing back to the neck. In consequence the early railway builders took advantage of the low level on the bay shore to bring the tracks to a point about halfway down the shore line. Since the construction of the road, over 50 yr. ago, the city has grown southward, so that at present the center of business is a long way from the terminals, and, more important, the shore south of the terminal has become crowded with private wharves, warehouses and factories, the removal of which to permit a southerly extension of the railway would be most costly.

For many years the ocean terminals have been in the congested districts just south of the railway passenger station, and in 1910, in an effort to improve conditions, the government undertook the reconstruction of this section, starting with the building of Pier 2, the large reinforced-concrete pier described in *Engineering News* of June 24, 1915. It was felt, however, that such provisions were only makeshifts and that some radical revision of the whole harbor must be made if the port were to be developed to meet the national needs anticipated in the Canadian transcontinental and transoceanic trade expansion consequent on the rapid development of this vast country. To provide for this expansion the Intercolonial Ry. has been greatly improved and will be double-tracked with revised grades from Moncton to Halifax.

The Intercolonial Ry. now entering Halifax and its connecting line, the National Transcontinental Ry., both of which are under government control form a continuous line from Halifax to Winnipeg under one management. At the same time the privately owned railways of Canada are being extended with a vigor comparable to the best progress made at a similar stage in the development of the United States. It has therefore naturally become a part of the Dominion's economic policy to develop an entirely Canadian control of the expanding trade between its people and Europe and to supplant the present partial control of existing trade by United States railways and ports, dictated entirely by present superior economic advantages.

Halifax seems to have at least three dominant advantages to further this policy. It is the nearest port to Eu-

rope open all the year round and at all times, and should therefore be most desirable for transatlantic mail and passenger routes. It is a safe and easily accessible summer and winter port for Canada, thereby differing from the St. Lawrence cities. It is an all-year port of call for shipping between Europe and North America. The last-cited circumstance is considered a most important factor, as it promises to guarantee a sure and constant outlet to trade even though the port is not established as a terminal. The accepted path of transoceanic steamers bound for United States ports would be lengthened only from 20 to 50 mi. in calling at Halifax.

As a result of these considerations the government in 1912 decided to establish at Halifax a new deep-water terminal which should furnish safe and accessible landing facilities for vessels of the largest and most modern type and communicating railway terminals for passengers and freight located in the most desirable situation with regard to city population and industries.

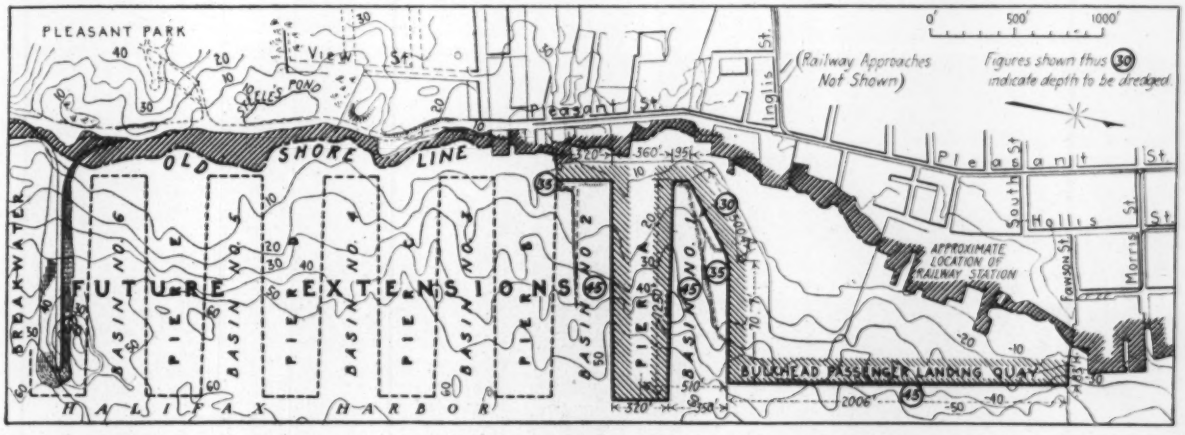


FIG. 2. LAYOUT OF QUAY AND PIERS AND LOCATION OF RAILWAY TERMINAL AT HALIFAX

An extended study of the harbor was made and designs were outlined at four different places—two at Dartmouth on the opposite side of the bay, one an extension of the old terminals near the station and one, which was adopted, near the south end of the peninsula. The Dartmouth schemes across the bay from Halifax were abandoned mainly because of the isolation of the sites, it being assumed from previous experience at other ports that it is difficult to establish new terminals removed from existing business centers. The extension of the present terminals was rejected largely because of the poor approaches along the narrow shore level and the expensive dislocation of the business district which would be required. The southerly plan was adopted because it did not have the disadvantages noted in the foregoing and in addition had several decided advantages, which can be enumerated as follows:

(1) A location convenient to the center of the city; (2) utilization of a part of the city waterfront hitherto little developed, and largely unoccupied; (3) comparatively small effect on assessment value and taxation; (4) turning space in front of the terminals sufficiently large to permit the maneuvering of the largest ships; (5) convenience of the topography for a railway-terminal location; (6) sufficient depth of water to care for any ship now in existence or in contemplation; (7) room for a large freight yard; (8) possibility of extension at small cost.

The location of the new deep-water terminal is shown in Fig. 1 and the layout in Fig. 2. It consists of a landing quay 2,006 ft. long and six piers with six berthing basins, all physically connected with a passenger and freight terminal approached by a double-track railway, which enters the city across the neck of the peninsula and connects with the piers through the point at the south end of the city. At the piers full equipment is to be provided in the way of warehouses, elevators and railway-terminal facilities, while on the shore of Bedford Basin, just before the railway makes its new detour back of the city, is to be built a large freight yard. A depth of 45 ft. of water is to be provided at all berths except two which will have 30 and 35 ft. respectively.

The whole project, from freight yard to terminal, is in territory not now in commercial use, so that business can be transferred from the old to the new location without interference or delay. At present only the railway connection, the landing quay, Pier A and the breakwater are under construction. In immediate prospect, however, is the erection of an elaborate terminal building which will house under one roof the required facilities for steamship- and railway-passenger service.

The total area to be used for the terminal will be about 260½ acres, of which 198½ will be land and 62 in water. The bulkhead landing quay, as stated, is 2,006 ft. long, will have a minimum of 45 ft. of water alongside and will carry for its full length a passenger and freight building, the ground floor of which is to be used for freight and the second floor for passengers, baggage, mail and express, connecting through a large concourse to the new Union passenger station for all the railways. On the north side of Basin No. 1 are berths for two ships, one 700 ft. long, with a minimum depth of 35 ft. of water and the other 500 ft. long with 30 ft. of water and each provided with double-story freight sheds 100 ft. wide, with three tracks at the back and one along the front of the quay. The five piers and basins (which have not as yet been started) will each be 1,250 ft. long and each from 320 to 360 ft. wide. The basins will be dredged to give a minimum depth of 45 ft. at low-water level. There will be four berths to each pier and each berth will be provided with two-story sheds and ample track connections. The layout of the station and terminal tracks is not yet complete.

At the extreme southern, or seaward, side of the piers a paved rubble-mound breakwater is being built along with the first unit of the docks. The breakwater will extend eastward from the shore into the harbor for a distance

of about 1,500 ft. and will be built out to and upon an isolated ledge of rock which is at present in places very close to the surface of the water. When required by demands of business, a quay wall can be built along the inner side of the breakwater, which will itself then compose the centering for a new pier.

The landing quay and the piers are to be of earth and rock fill behind concrete walls of novel construction. The design was selected after careful study of the requirements, which may be outlined as follows:

(1) The great depth of water (45 ft.) to be provided at low water; (2) the varying levels of the present bottom of the harbor, particularly of the rock surface; (3) the dip in the strata and the irregular nature of the rock and its broken and laminated character; (4) the impracticability of coffer-damming on account of the exposure, great depth of water and danger of leakage through the rock; (5) the effect of the frequent ground swell and wind and waves on any staging and floating plants, difficulty in securing good bottom for piles and anchors, great length of spuds required for dredging with scows and the regulation of the plant to the rise and fall of the tide; (6) the low range of the tide and consequent difficulty in securing bracing for either temporary or permanent works; (7) necessity for practically a vertical-face wall on a wharf to suit the modern midship section; (8) necessity for protecting the face of the walls against disintegration from frost or sea water and the action of ships; (9) avoidance of taking out any more rock from under water than is absolutely necessary and having to replace it with concrete; (10) reduction of diver and expensive subaqueous work to a minimum; (11) necessity for rapid construction.

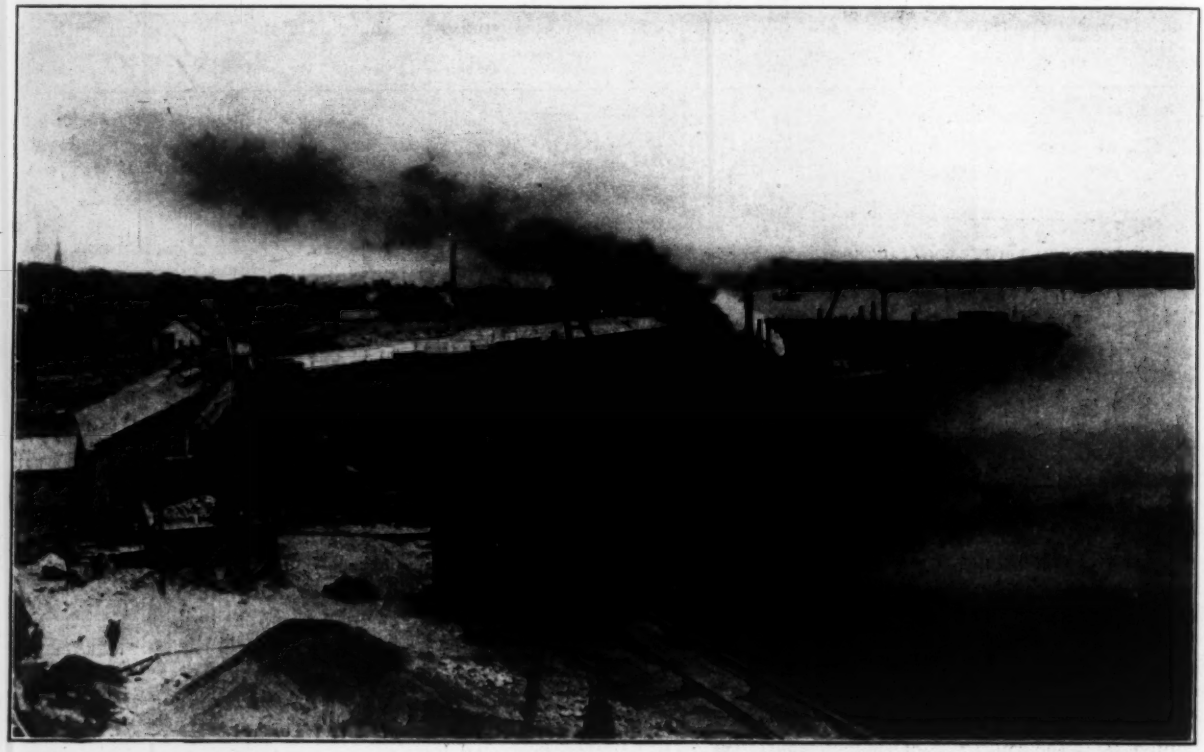


FIG. 3. LOOKING NORTHEAST ACROSS HALIFAX HARBOR FROM SHORE END OF FUTURE PIER A

Quay-Wall and Pier Construction

The quay-wall method of construction consists in placing on a prepared bottom, in 30 to 60 ft. of water, stacks of hollow reinforced-concrete blocks fitting one on top of the other to form the required height and joined together laterally to form the continuous wall. After setting these blocks, their cells, which line up vertically, are to be completely filled with concrete for the first 5 ft. and above that each stack is to have its face cells and the middle line of transverse cells filled with concrete, the remainder of the other cells to be filled with stone rip-rap and sand so that in effect the completed wall will be a retaining wall with a concrete base and a concrete face strengthened with solid counterforts. Topping the wall above low water will be a granite-faced wall in the intertidal space and up to and including the coping, as a protection against the frost and sea-water action which might damage the concrete. The shed and warehouse structures will have their forward columns supported directly on the wall and their rear columns on pedestals footing on concrete-pile clusters driven through the fill which will be placed after the wall is completed.

The advantages of this method are that all the concrete is mixed with fresh water, molded in air, and allowed thoroughly to mature before coming in contact with sea water and placed so that it will not be subject to frost action. The mass concrete that is deposited under water is placed under conditions as nearly ideal as possible. The design of the walls obviates the necessity of using expensive temporary staging or floating cranes. Expensive foundations for the front row of the shed column are unnecessary. Settlement, expansion and contraction are provided for by means of the short sections and the leeway afforded by the reinforced-concrete guides.

While cellular concrete blocks for subaqueous wall construction are not new, in no other work have they been developed to such magnitude as at Halifax, nor has the method of placing and filling them ever been used before. At the present over 1,100 out of the 3,634 blocks required have been cast and are in storage at the site (see

Fig. 7), but the placing has only just started, the view in Fig. 8 showing the first block being swung into place on Sept. 25. The method in which the blocks are intended to be laid—which in the limited practice so far offered has proved very successful—can be outlined. The process of laying is also sketched in Fig. 6.

Placing the Concrete Blocks in Wall

The details of a typical block are given in Fig. 5. As shown in the general elevation, this block is only typical of those in the main part of the shaft, there being special shapes and sizes for the base blocks and for the top blocks. The block shown, however, is sufficiently typical for purposes of description. It is 31 ft. wide, the width

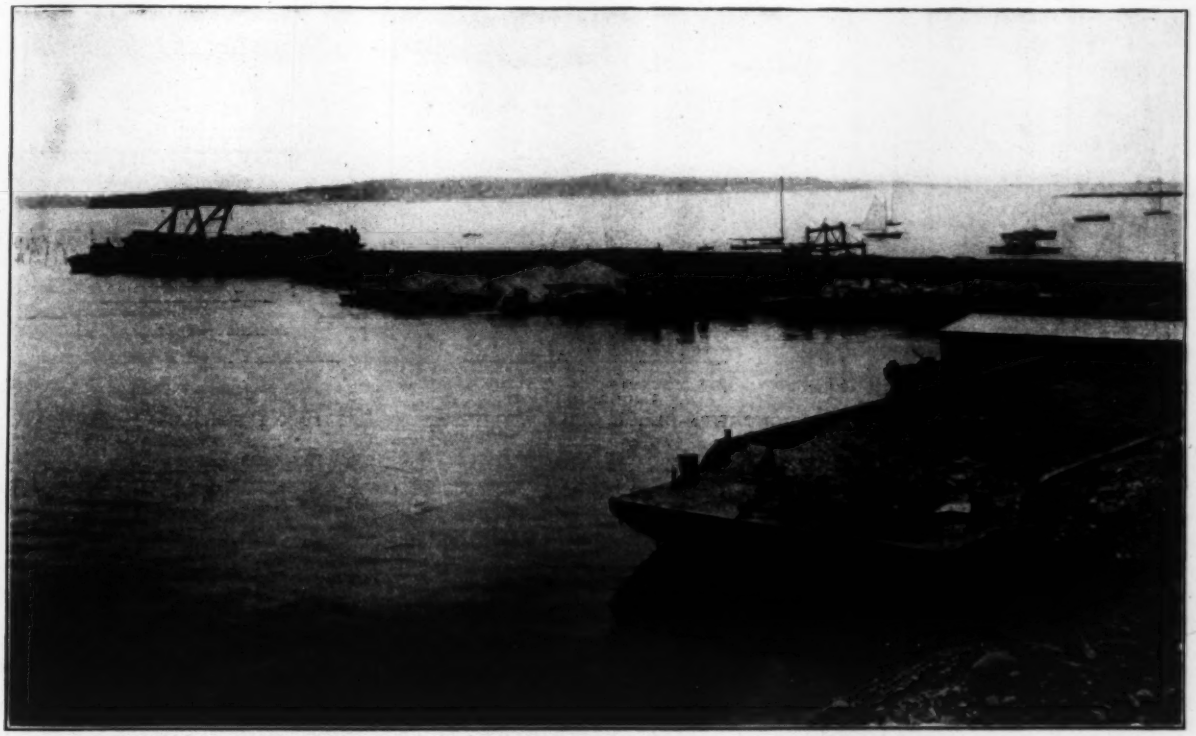


FIG. 4. LOOKING SOUTHEAST ACROSS HALIFAX HARBOR FROM SHORE END OF FUTURE PIER A

of the completed wall; 4 ft. high and 22 ft. long, and weighs 60 tons. It is reinforced not only against its loads as a part of the wall but against handling stresses. The walls are solid except for the triangular openings shown (provided so as to insure a good bond with the fluid concrete placed in the cells) and also vertical circular openings for grouting, as afterward described. On each side are provided triangular vertical openings which serve as grooves to engage the square guide posts used in setting the blocks. These posts are in appearance the same as reinforced-concrete piles and are cast in a similar manner. Great care is taken in getting plane surfaces and truly right-angled edges in the blocks, for upon these features depends the verticality of the finished wall.

The surface of the bottom, upon which the lowest block is laid, is prepared by dredging, or where already low, by filling up to the required grade with mass concrete or a rubble mound. The final leveling is made in the chamber of a diving bell, to be described in a later article. Inside of this bell the subsurface is cleaned up and where necessary at the back or front brought to proper elevation by filling holes or depressions with concrete, and then low concrete pedestals each about 5x6 ft. footing on solid rock (or concrete or rubble fill) are laid, with tops finished to true grade about 3 in. above the surrounding bottom. These pedestals are located at back and front at the junctions of stacks of blocks. The first block is then picked up with special tongs slung from a traveling crane, the jaws of the tongs fitting into specially prepared openings in the bottom of the block. With the crane running on a standard gage track and standing with outriggers set on an already completed stack (see Fig. 6), the block is lowered overboard, effort being made to keep it lightly engaged against the vertical guide posts which have been plumbed and fastened into the corresponding grooves in the last stack already set. After the block is lowered to bearing on the pedestals, the succeeding blocks of the stack are placed until the stack is complete. The sealing concrete for the two bottom risers is then placed by bottom-dump buckets from a floating concrete mixer or delivered from the molding yard concrete mixer by flat cars running on the standard gage track behind the crane, and then the filling of the proper cells with concrete to the top of the stack is completed. After this filling is finished, grout is forced into the vertical 10-in. holes, which, matching up, form a continuous well through the stack. It is expected that this grouting will fill any voids left where the bearing of the blocks is not perfect or the concrete filling has left holes. Finally the remaining cells are filled with rubble gravel and sand.

The placing of the blocks has from the first been attended with the greatest success. The guide and key posts which are carefully plumbed for each stack automatically bring the blocks into true position without the

assistance of a diver whose services are required only for inspection and to see that all is clean and clear for the bottom blocks and mass concrete of each stack. No difficulty is found in keeping the stacks vertical or in securing good alignment. The tendency to "creep" longitudinally or to get out of line is corrected by using different combinations of the three standard sizes of posts provided. The variation in levels between the highest and lowest corners of the top blocks of the stacks as set does not average more than ½ in. Blocks for about 500 ft.

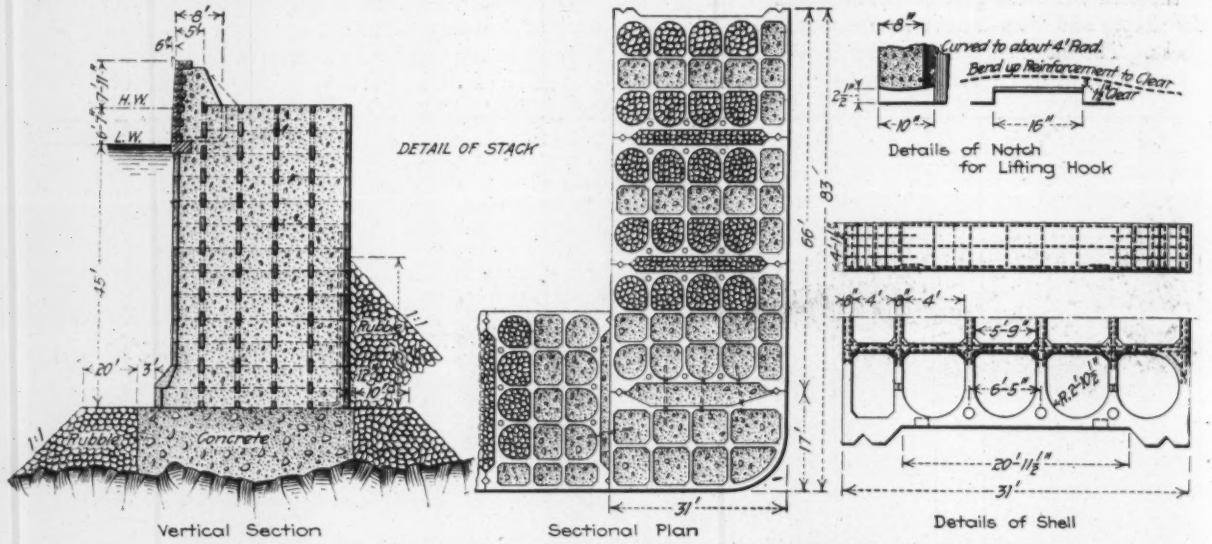


FIG. 5. DETAILS OF THE CONCRETE-BLOCK QUAY WALL USED IN HALIFAX TERMINALS

of wall have already been set with a 150-ton standard-gage steam locomotive wrecking crane which travels out on ordinary railway track laid on stringers resting on the stacks of empty blocks and extended by stack lengths of 22 ft. as the block setting proceeds. The same crane is used for lifting the blocks from the molding platforms to standard flat cars on which the blocks are transported out to the wall head. As many as two stacks each of nine blocks have been set in one working day and an average per day of one stack of blocks loaded from the yard and set in the wall is easily maintained.

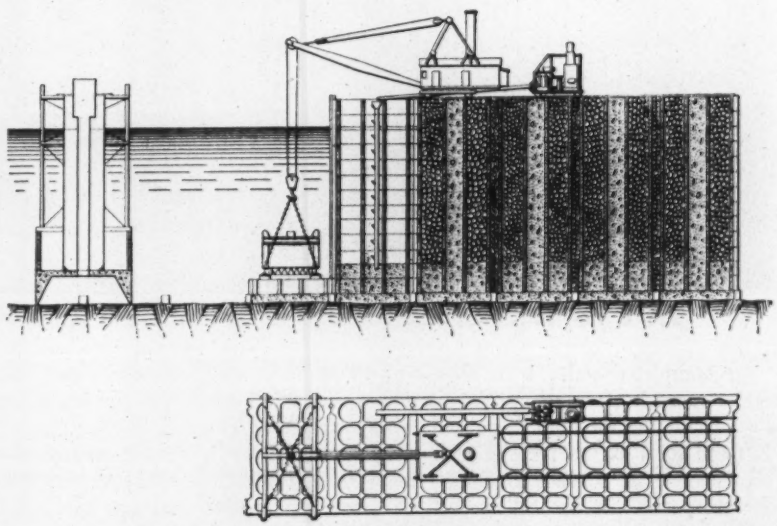


FIG. 6. SKETCH SHOWING METHOD OF LAYING BLOCKS IN QUAY WALL

As the map in Fig. 1 shows, the new railway entrance leaves the old main line at the lower end of Bedford Basin and continues down the west side of the city to the terminals, a distance of about 6 mi. Except for the freight yard along the shore of the Basin and the four-track approach to the terminal yards, the line will be two-track. On account of the topography and the short length of the new line, it was impossible to balance the cuts and fills, so most of the work is in cut, the spoil being carried north to make the freight yard and south to the breakwater and back fill of the quay and pier walls. The total excavation is about 1¾ million cubic yards and the deepest cut about 60 ft.

Some difficulty was experienced in locating the line because the Northwest Arm, along which it runs, is a beautifully wooded section highly desirable as a residential, park and recreation district. On this account the line was kept well back from the water, and all crossings of streets leading to the water side district are to be carried above grade on handsome reinforced concrete arch bridges.

Subaqueous Excavation

The landing quay and piers were located to fit as closely as possible to the natural shore line so that excavating below water for the required depths would be at a minimum. However, it is necessary to dredge about 250,000 cu.yd. of the rock bottom to attain the desired low-water depths (maximum 45 ft.), and this spoil is used mainly in filling in behind the walls. This excavation for the most part is in fairly hard rock which requires blasting before dredging; but in some low areas the rock lies at a depth of from 50 to 90 ft. and it is necessary to dredge out the overlying mud. In these sections a granite rubble mound is deposited to form a foundation for the quay-wall blocks.

The railway connection to the terminals and the details of the contract work which comprise the block-making,

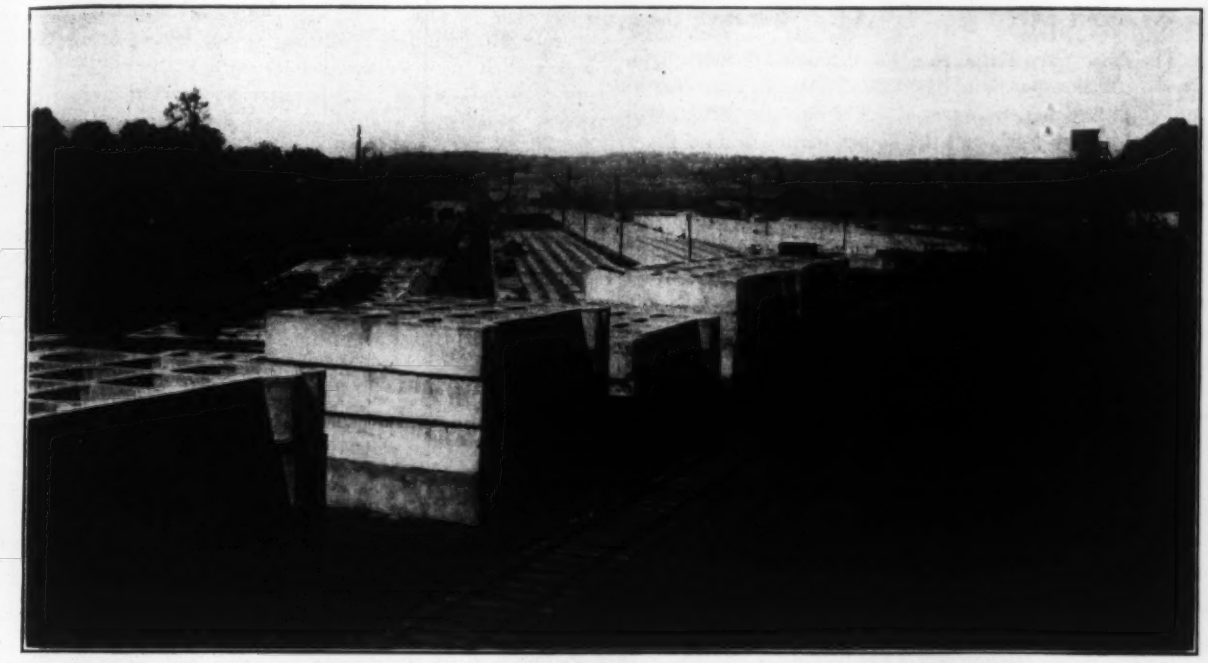


FIG. 7. VIEW OF CONCRETE BLOCKS IN STORAGE IN HALIFAX YARD

dredging, diving-bell methods, quarrying, etc., will be described in later articles.

The deep-water terminals at Halifax are being built by the Department of Railways and Canals, under the direction of the Minister, Hon. Frank Cochrane, and under the direct personal supervision of F. P. Gutelius, General Manager of the Canadian Government Railways. Design and construction are in immediate charge of James McGregor as Superintending Engineer, with F. W. Cowie, of Montreal, as Consulting Engineer on the dock works and C. B. Brown, Chief Engineer of the Canadian Government Railways, as Consulting Engineer on the railway works. A. C. Brown is Resident Engineer on the dock works, R. H. Smith is Resident Engineer on the railway works and J. J. Macdonald is Office Engineer. The railway grading contract is held by the Cook Construction Co., Ltd., and Wheaton Bros., with Andrew Wheaton and I. J. Bowes in charge, and the dock contract by Foley Bros., Welch, Stewart & Fauquier, with J. P. Porter and R. B. Porter in charge of operations representing the company and J. W. Roland as their Chief Engineer.

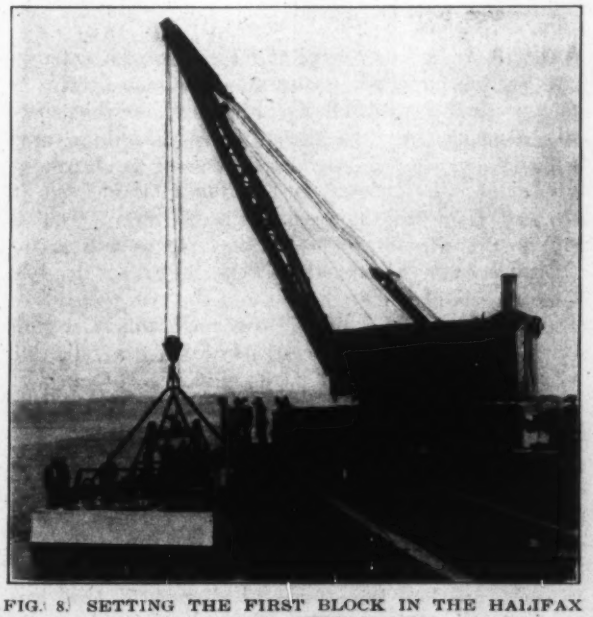


FIG. 8. SETTING THE FIRST BLOCK IN THE HALIFAX QUAY WALL, SEPT. 25, 1915

British Cement Specification

In a new edition of the British Standard Specification for Portland Cement (obtainable from the Engineering Standards Committee, 28 Victoria St., Westminster, London, S. W.) some changes in the fineness and strength provisions are made. The new fineness clauses allow a maximum residue of 14% through a 180-mesh sieve and 1% through a 76-mesh. The maximum tensile strengths for seven days have been raised to 450 lb. per sq.in. for neat cement and 200 lb. per sq.in. for 1 : 3 mortar.

The growth of tensile strength required at 28 days both for neat cement and cement and sand is now obtained by means of a formula in place of the fixed percentages which have been specified hitherto. The formula gives a progressive increase instead of the somewhat irregular steps of the method previously adopted, but has the effect of requiring a somewhat increased percentage of growth on the higher seven-day figures.

The clauses dealing with the preparation of the briquettes have been amplified, the procedure being described in greater detail than has previously been the case. Ramming and hammering are expressly prohibited, but the wording of these clauses still leaves scope for wide differences of opinion as to the quantity of water to be used and the precise methods of filling the molds. In the test for final setting time the Vicat needle is provided with a fixed metal circular cutting edge set ½ mm. back from the point, with the idea that this will clear the scum which sometimes forms on the surface of the pat.

Buffalo Barge Canal Terminal

The New York Barge Canal will terminate at Buffalo, N. Y., in the old Erie Basin, which is being deepened and improved for the purpose. The basin extends north along the shore line from the mouth of the Buffalo River to the new Black Rock channel and is formed by the old New York State breakwater, of stone masonry. There were originally three piers running from the inner side of the breakwater, and the depth of water was about 9 to 14 ft. Of late years the basin has become obstructed by a number of sunken vessels and scows.

The work of adapting the basin for the Barge Canal terminal consists of building two piers out from the shore, deepening the entire area to 23 ft. of water, removing the old piers at the breakwater, and removing about 400 ft. of the south end of the breakwater in order to give an outlet to Lake Erie.

The plan of the terminal basin is shown in Fig. 1. The work is under the direction of Frank M. Williams, State Engineer. L. D. Brownell was formerly Resident Engineer and E. H. Anderson is Assistant Engineer in Charge. H. S. Kerbaugh, Inc., of Buffalo, has the contract.

Deepening the Basin

The depth of water was from 3 to 12 ft., with rock at a depth of 15 to 25 ft.; but rock excavation was required over nearly the entire area. The material above the rock was mainly sand and clay, with some hardpan. The loose material (860,000 cu.yd.) was removed with a large dipper dredge having a 50-ft. steel boom and a bucket of 7-cu.ft. capacity. The wrecked vessels were mainly removed by means of a derrick boat 181x36 ft., having at each end a stiff-leg derrick of 75 tons' capacity, with 53-ft. mast and 83-ft. boom.

For rock drilling, two drill boats are employed, one having five and the other four drill frames. These drill 3½-in. holes to a depth of about 26 ft. below water. Each hole is charged with about 50 lb. of 60% dynamite, the cartridges being put down through a 2¼-in. pipe in the drill hole. The shattered rock (280,000 cu. yd.) is removed by the dredges and either loaded into scows or deposited directly at the site for the new piers.

Construction of the Piers

The two piers will be used for the transfer of freight between the canal boats and railway cars or lake vessels. They will be diagonal to the shore line, as shown in Fig. 1, with lengths (on the longest side) of 576 ft. and 397 ft. Both will be 150 ft. wide. Between them will be a slip 250 ft. wide. The sides and ends will be formed of rock-filled timber cribs resting on a bed of broken rock and surmounted by concrete walls 8½ ft. high, having their tops 6½ ft. above water level. This construction is shown in Fig. 2. The space between the two lines of cribs will be filled with dredged material, the rock being deposited against the cribs and the loose material in the central portion.

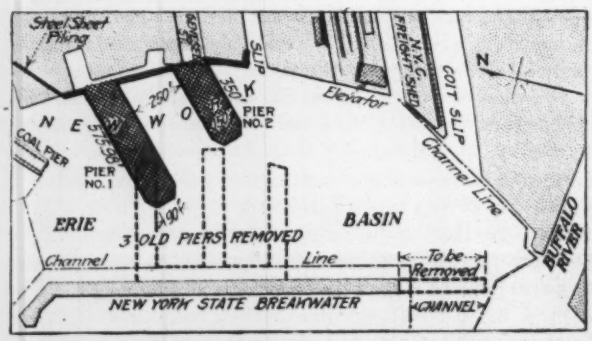


FIG. 1. PLAN OF THE TERMINAL FOR THE NEW YORK STATE BARGE CANAL AT BUFFALO, N. Y.

The bulkhead walls at the shore line will be of similar construction. A line of steel sheetpiling will extend from the north end of the bulkhead to form one side of a 280-ft. slip along the coal pier of the Philadelphia & Reading R.R., as shown.

The cribs, Fig. 3, are 20 ft. wide and 20 ft. high, built in lengths of 100 ft. They are of 12x12-in. timbers, with planking on the bottom course to retain the rock fill. The timbers are put together with horizontal 1¼-in. screw bolts, 26½ in. long, and vertical 1-in. button-head drift bolts, 22 and 30 in. long. The drift bolts are

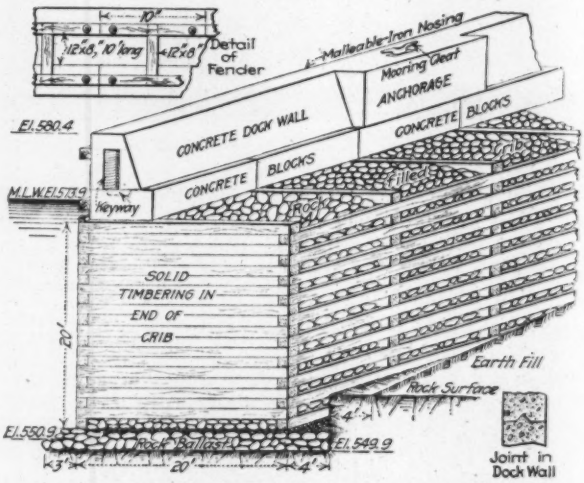


FIG. 2. CRIB AND CONCRETE WALL CONSTRUCTION FOR PIERS AND BULKHEADS

slightly inclined, as shown, and are driven in ⅛-in. bored holes.

The 100-ft. cribs are built at the edge of the water on a tilting platform, which turns on trunnions. This is counterweighted to stand normally level, so that there will be no danger of its tilting while the crib is being built. When a crib is completed to about two-thirds its full height it is launched by hitching a tackle from an overhead frame to the rear of the platform. This is done so that it will not be too heavy for handling, the remaining timbers being added while the crib is floating. Some rock is placed for ballast and the crib then towed to place and sunk by filling with rock from a derrick scow. Dredged material is added to make a solid fill.

Concrete Dock Walls

The concrete walls forming the faces of the piers and the bulkheads are built up of a bottom course of concrete blocks and an upper course of monolithic construction. This is shown in Figs. 2 and 4. The lower course consists of flat blocks 10x6 ft., 3 ft. thick, with recesses in the top and ends and weighing about 15 tons each. In each block are three loops or stirrups of 1-in. bars for the hoisting slings. These blocks rest directly on the

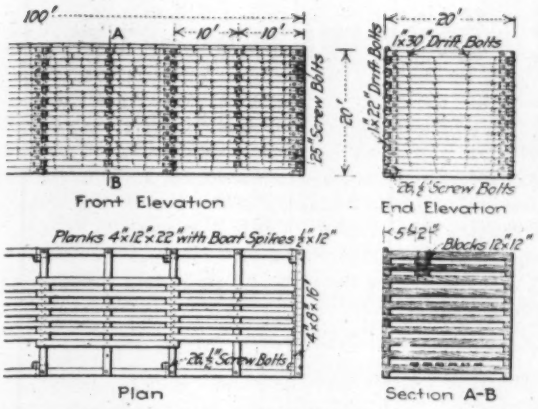


FIG. 3. TIMBER CRIBS FOR PIERS AND BULKHEADS

top timbers of the crib, at its outer face, but are set back about 12 in. from the edge.

The upper part of the wall is poured in place, in lengths of about 40 ft. Its joints are made to correspond with those of the concrete blocks below. The ends of the sections are connected by vertical keys and keyways of triangular section, and the keys are painted with asphalt. This part of the work is 5½ ft. high, 4 ft. 10 in. wide on the base and 3 ft. on top, the water face being vertical. At intervals it is made wider in order to carry the cast-iron mooring cleats. The concrete mix will be 1 : 2½ : 5, with Niagara River gravel for the coarse aggregate.

The upper edge of the wall is protected against wear by a continuous rounded nosing of malleable iron. Along the face of the wall is a fender of two lines of 12x8-in. timbers, with posts of the same size 10 ft. apart. The timbers are secured to the wall by bolts in iron tubes embedded in the concrete.

Operating Results of the Palo Alto Refuse Incinerator

The incinerator put in operation by the City of Palo Alto, Calif., Jan. 7, 1914, described in detail in *Engineering News*, Mar. 4, 1915, p. 432, and May 27, 1915, p. 1040, has a daily capacity of 30 tons of mixed refuse, garbage, etc. The incinerator is of the Dundon high-temperature type, with a single cell, a level drying hearth, forced draft, a combustion and supplementary combustion chamber, boiler, and air and water heaters. The furnace has two grates and a total grate area of 33 sq.ft. There is special machinery for handling refuse, dead animals, ashes and clinkers. The plant cost about $18,000.

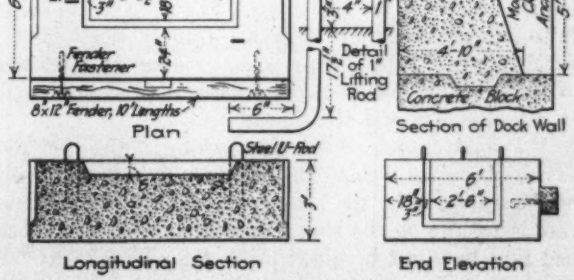


FIG. 4. CONCRETE BLOCKS AND MONOLITHIC CONCRETE WALL, BUFFALO BARGE CANAL TERMINAL

The total amount of refuse burned in the year ending June 30, 1915, was 1,871.66 tons. The weight of residual clinker, ash, etc., was 449.74 tons. The average amount of refuse burned per hr. was 0.75 ton, and the average burned per sq.ft. of grate area was 45 lb. per hr. The amount of water evaporated per lb. of refuse (boiler pressure 140 lb.) was 0.09 lb., which is exceptionally low because the boiler was operated only a small part of the time. Ordinarily the water evaporation at 140 lb. boiler pressure is about 0.25 lb. per lb. of refuse. The average composition of the refuse was 1,044 lb. of water, 401 lb. of combustible matter and 555 lb. of non-combustible matter per ton of refuse. The population of Palo Alto is about 5,500.

OPERATING COST DATA OF PALO ALTO REFUSE INCINERATOR

Credits		
Receipts from refuse collection charges		$3,051.00
Sale of steam to power plant		84.62
Sale of junk		19.85
Receipts from cremating 9 horses, 3 cows, 19 dogs		23.00
Miscellaneous receipts		25.23
		$3,203.70
Debits		
Cost of operation:		
Destructor plant wages	$1,487.30	
Power	70.92	
Fuel	26.62	
Supplies	9.50	
Maintenance	11.00	
		$1,605.34
Cost of collection:		
Refuse collectors' wages	$2,404.90	
Wagons	12.00	
Teams	10.00	
Repairs	41.45	
		2,468.35
General expense:		
Salaries	$385.00	
Printing and stationery	194.95	
Sundries	74.65	
		654.60
Bond interest		893.09
Depreciation		700.13
		$6,321.51
Loss in operation		$3,117.81

Under the method of collection in force in 1914-15 a direct charge was made for garbage and refuse collections, varying from 15c. per month for collections once a month to $1.75 per month for daily collections. This resulted in a deficit of about $110 per month, and since July 1, 1915, the following schedule of collection charges has been in force:

Removal of garbage twice per month	$0.25 per mo.
Removal of garbage once per week	.50 per mo.
Removal of garbage twice per week	.80 per mo.
Removal of garbage three times per week	1.25 per mo.
Removal of garbage six times per week	2.50 per mo.

The refuse to be removed is not limited to garbage, but includes all forms of waste matter and tree trimmings, which are taken care of by the garbage collectors without extra compensation.

A sanitary inspector is appointed whose duty it is to examine all premises not less than once a month and report any violations of the collection ordinance to the health officer. According to the ordinance the garbage is to be collected at least once per month.

Recovery of Byproducts from the Pickling Liquor of tinplate and galvanized-wire plants is announced from Pittsburgh as an early probability. Experiments appear to show that both acids and pigments may be obtained from the pickle. Different colors or tints would be produced by subjecting the solids to varying degrees of heat.

Freight Yard at Birmingham

SYNOPSIS—This new yard is of the gravity switching type. It takes the place of four old yards and is designed for future enlargement. It includes engine terminal facilities. Some of the special features of the plant are described.

To meet the requirements of increasing traffic at Birmingham, Ala., the Southern Ry. has built (at North Birmingham) a freight yard and engine terminal representing an expenditure of about $661,000. This has been named the Finley yard, in honor of the late president of the railway. It supersedes four old yards in the same district and was designed to provide for the probable needs of the next 25 yr., separate units to be built as required. The present unit includes a receiving yard, gravity classification yard, storage yard and repair tracks, roundhouse, sewers and water-supply system, coal-, cinder- and sand-handling plants, and lighting and compressed-air facilities. The freight yards have a total capacity of about 2,000 cars. The plan and the profile are shown in Fig. 3 and some of the special features are described below.

FIG. 1. CINDER PITS AND CINDER-HANDLING PLANT IN THE FINLEY YARD

Freight Yards

The receiving yard consists of eight tracks (45 cars each) and two running tracks, the former laid 12½ ft. c. to c., the latter 15 ft. c. to c. The grade is level for about half the length, and then ascends at 0.5% toward the switching hump. The classification yard has 16 tracks (47 cars each) and two running tracks, spaced as previously mentioned. The grade is mainly 0.25%.

There are five caboose tracks (173 caboose cars), two repair tracks of 74 cars' capacity, ten local freight and storage tracks (53 cars each) and a six-track coal-storage yard (35 cars). The coal-storage tracks descend at 1%, so that cars are run to and from the hopper by gravity.

Switching Hump

In building humps or inclines for gravity switching, the Southern Ry. fixes the grades by actual tests, cars being run over the hump and the grades adjusted to meet the local conditions. This is done not only in new yards, but also in old yards when new scales are installed. The grades for the hump at the Finley yard are shown in Fig. 3. The grade ascending from the receiving yard is 1.7%. The descent commences with a short starting grade, followed by 0.6% over the scales, 3.8% to the foot of the hump, 0.89% along the ladder and 0.35% through the classification tracks. Vertical curves, 20 to 50 ft. long, are used at all grade intersections. A concrete subway eliminates the necessity of employees crossing the hump tracks.

150-Ton Track Scale

The track scale on the hump track is of the suspension-bearing type, 150 tons' capacity, in four sections. It is 54 ft. long, with a live weighing surface of 50 ft., and has an automatic weight recorder with a device which prevents a weight being recorded when more than one car is on the scale. The main and extension levers are of cast iron, the fifth lever is of cast steel and all pivots and bearing steels are of special alloy.

The scale is installed in an open pit, as shown in Fig. 2, having concrete abutments and two intermediate piers on each side to support the dead platform. The platform stringers support the dead rails by malleable-iron castings the thickness of the timber deck. The live rails are supported by short sections of I-beams which rest on the weigh-bridge girders and project between the floor-beams to the platform surface.

The weigh-bridge is maintained on the 0.6% grade by means of adjustable wedge blocks. Lateral movement is checked by adjustable side buffers and longitudinal movement by buffers on the ends of the girders and just clearing steel plates in the abutments. The live and approach rails are connected by Bohannan-Dugger easer joints, which prevent excessive impact and reduce the vibration of the scale mechanism. This mechanism is protected by a timber deck and dirt shields.

A special feature is an interlocking device for the switch above the scale. This prevents unauthorized use of the scale (as for the passage of engines); it prevents cars being run on the scale before the weigh-master has had time to adjust it, and it places the responsibility for weighing and care of scales. Two interlocking levers are fitted in the scale house, the door of which must be

closed before either lever can be operated. The door being closed, the throw of the first lever locks the door and unlocks the lever controlling the switch. The throw of the latter then locks the door-controlling lever. Before the weigh-master can open the door to leave the scale house he must close and lock the switch by throwing the second lever.

The track at the lower end of the scale is equipped with a spring switch. For night work there are two electric headlights so mounted on posts that their rays intersect 4 ft. above the rail and directly in front of the scale beams. General lighting of the scale and upper part of cars is furnished by a 40-watt cluster of lamps on the front of the scale house.

When a train having both weigh and nonweigh cars is being passed over the hump the foreman of the switching crew notifies the weigh-master of the approach of each weigh car by means of an electric bell in the scale house, operated by a push-button at the hump.

Engine Terminal Facilities

The roundhouse, 92 ft. wide, is of reinforced concrete, with a roof slab of concrete and hollow tile covered with tar and gravel roofing. There are 25 engine pits, with one truck-wheel drop-pit and one driving-wheel drop-pit. The windows are of wire-glass and metal sash, each window having an area of 284 ft. (58% of the panel area). The floor is of creosoted-wood blocks on 5 in. of concrete. The turntable is 90 ft. long, motor-operated, in a concrete pit.

The ash-handling plant is of special interest and is shown in Fig. 1. There are four ashpits, 160 ft. long, arranged in pairs, each pair equipped with an electric overhead traveling crane. The cranes have a span of 46 ft. 8 in., supported by steel runways on bents 20 ft. 6 in. c. to c., with a clearance of 16 ft. over the tracks. They handle 1½-yd. grab buckets. Each crane is operated by one man. The pits are of plain concrete, 4x4 ft., with track rails fastened to inverted channels secured to the top of the walls by U-bolts. The bottoms are sloped for drainage and are protected from damage by the grab buckets by means of two rails embedded at the surface of the concrete.

The coaling station (of reinforced concrete) has a capacity of 1,000 tons, of which 60 tons is held in four

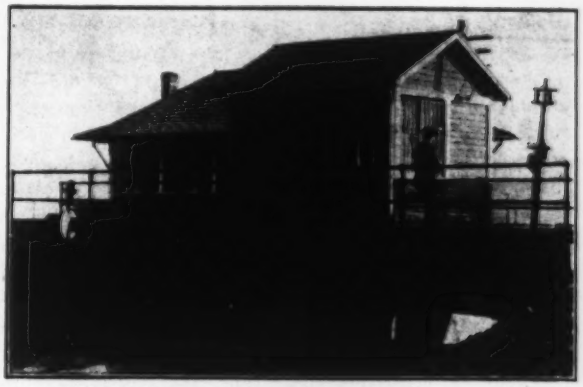


FIG. 2. TRACK SCALE WITH OPEN PIT ON THE SWITCHING HUMP IN THE FINLEY YARD

15-ton scale pockets, fed from the main bin above. Coal is dumped from hopper-bottom cars into a track hopper and elevated to the storage pocket by a motor-driven elevator of the chain-and-bucket type at the rate of about 100 tons per hr. Locomotives on either of four tracks are supplied with coal from the scale pockets. The scales are fitted with type-registering beams, enabling the operator to determine the amount of coal taken by each engine.

The sand-storage and drying building, of reinforced concrete, has a capacity of 100 cu.yd. of wet sand. From the track hopper the sand is elevated to the storage bin by a motor-driven belt-and-bucket elevator. It is fed by gravity to three stove driers under the bin and the dry sand is delivered to a steel drum, from which it is conveyed by compressed-air to a storage tank in the monitor of the coaling station. From there it flows by gravity to spouts at the coaling tracks. A motor-driven compressor is located in the drying room. Sand is delivered to the wet bin at about 35 tons per hr. and dried at the rate of about 1 ton per hr.

Air-Brake Testing Equipment

Facilities have been installed for testing the brakes on trains made up for departure. A motor-driven compressor, with a capacity of 1,000 cu. ft. of free air per minute (at 100 lb. pressure and 150 r.p.m.) delivers air to a receiver 54 in. in diameter and 12 ft. long, located above ground and about 50 ft. from the compressor house.

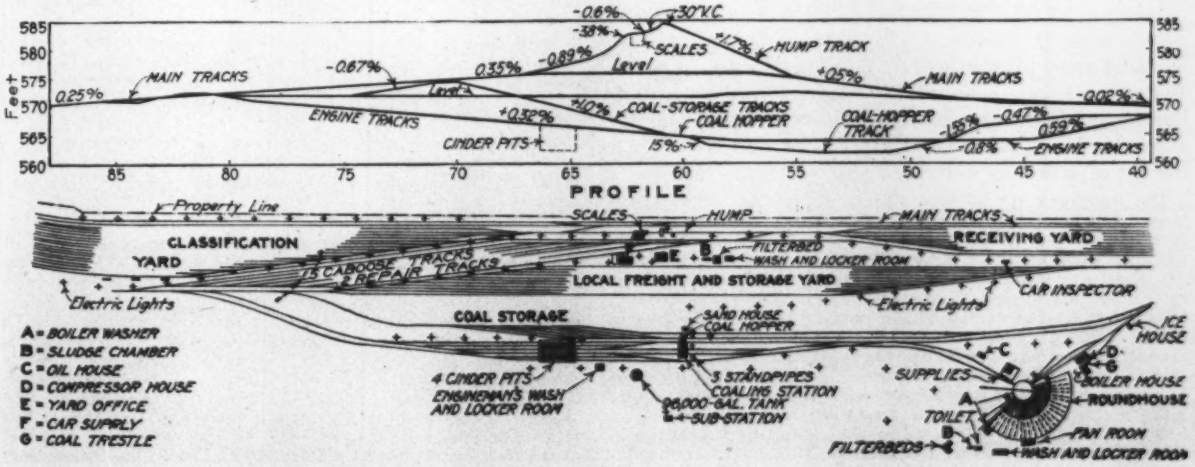


FIG. 3. PLAN AND PROFILE OF THE FINLEY FREIGHT YARD AND ENGINE TERMINAL OF THE SOUTHERN RY. AT NORTH BIRMINGHAM, ALA.

A 2½-in. wrought-iron main is laid in a creosoted-wood box so as to be readily accessible, and from this 1¼-in. lines are run to the center of each yard track at about the clearance point. Each is connected to an angle cock and standard hose coupling inside a reinforced-concrete service box, which is flush with the tops of the ties.

The distance from the air compressor along the 2½-in. main to the farthest service box is about 6,550 ft. There are 38 outlets, one at each end of 15 tracks in the classification yard and one at the west end of each of the 8 tracks in the local freight and storage yard. Condensation reservoirs, 24 in. diameter and 36 in. long, equipped with drain cocks, are placed in concrete pits at the lowest points in the main pipe line. The compressor also supplies air to the roundhouse.

Electric Light, Sewers and Water-Supply

The entire yard is lighted by 130 nitrogen lamps of 400 cp., located as indicated on the plan, Fig. 3. Some of the poles carry electric horns for audible signals to the switchmen. Current is purchased from a local company.

The local water company furnishes water for yard and fire protection purposes, the railway company installing the pipe lines on its property and having two elevated tanks, of 96,000 and 48,000 gal. A circulating high-pressure main for fire protection takes water directly from the water company's mains. There are two sewage-treatment plants, one near the roundhouse and the other near the yard office. Each consists of settling tanks and intermittent slow sand filter beds. The yard has a complete drainage system.

The terminal was built under the direction of B. Herman, Chief Engineer of Maintenance-of-Way and Structures, and T. H. Gatlin, Assistant Chief Engineer of Maintenance-of-Way and Structures.

Home Examination for Assistant Building Inspector

An unusual civil-service examination for assistant building inspector was held in Madison on Aug. 28 by the Industrial Commission of Wisconsin (Sydney G. Williams, Building Inspector). Each candidate wrote his answer in his home, without supervision. Accompanying the list of questions were the following instructions:

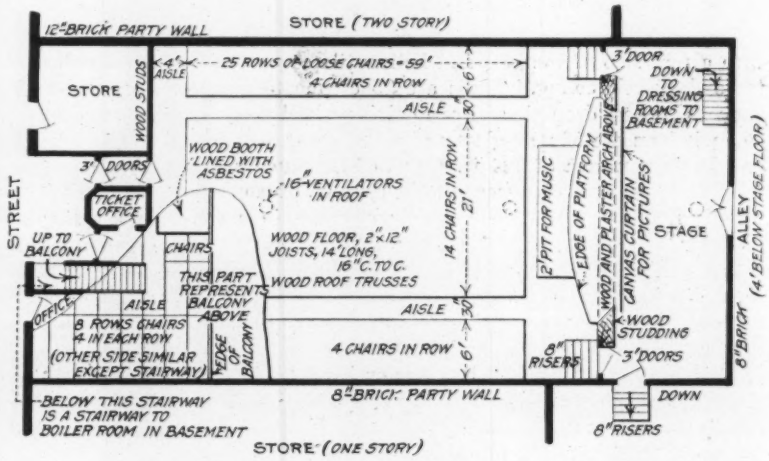
The questions are of such a nature that the answers can be written in 4 hr. You are permitted to consult any books or other printed matter that you desire, including the state-building code, of which a copy has been sent you, provided you note in connection with each question all books or other references which you consulted. You are not expected to have an exact knowledge of the requirements of the present state building code, but rather to answer the questions according to what you understand to be standard practice. You are also permitted to consult other persons if you desire, but you are advised not to rely on such information but to answer the questions on the basis of your own experience and judgment. You will note in connection with each question all persons whom you consulted.

The eight persons who passed the examination were assembled for an oral examination, which was designed to indicate the personality and judgment of the candidates. Written and oral examinations were given equal weight, and the three with the highest averages were appointed at a salary of $1,500 per year.

The method of examination was adopted, it is stated, because it is cheaper for both state and candidate, it enables the candidate to take the examination without the knowledge of his employer and it more closely approximates working conditions. The Wisconsin Civil Service Commission has employed the same general method in the selection of a supervisor of apprentices. The questions asked follow:

1. Discuss the purpose and methods of fire-resisting construction. What safeguards against fire would you employ in (1) a five-story reinforced-concrete hotel; (2) a three-story furniture factory, of mill construction, 100x150 ft.?

2. (a) Suppose you are sent to inspect a theater built some years ago in a town of 5,000 people, you find the theater to be as shown on the accompanying plan. What would you do? Suppose the manager of the theater says your requirements are unreasonable; that he has run the theater for 15 years



THEATER PLAN TO BE INSPECTED BY CANDIDATES

and never had a fire; that he would have to go out of business rather than make the changes which you ask. What will you do then?

(b) Let the same plan now represent the plan for a new theater, sent to you for approval. What changes, if any, would you require?

3. What are the main points of danger to workmen on new buildings? What would you (as state inspector) do to prevent accidents on a large building having a steel frame, concrete floors and brick wall?

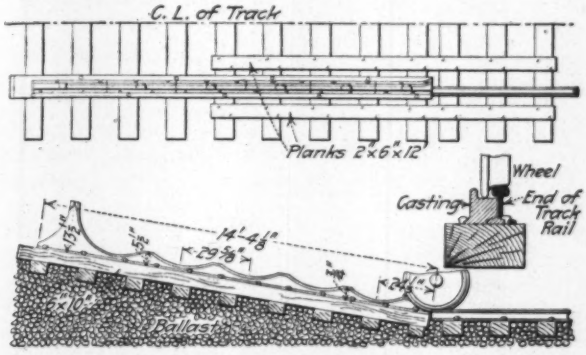
4. Design either (1) a reinforced-concrete floor over a school boiler room, 14x20 ft., the room above being a class room; or (2) a wood-joist floor for the auditorium of a church, 40x60 ft. in plan, one row of columns being permitted in the basement.

5. If ordered to inspect a three-story, twelve-family tenement house, what sanitary features would you investigate? What standards would you require?

Marketed Production of Phosphate Rock in the United States in 1914 was 2,734,043 long tons, valued at $9,608,041, according to W. C. Phalen, of the United States Geological Survey. There has been a decrease since 1913 amounting in quantity to 337,178 tons or 12%, and in value to 19%. The production of phosphate rock has been steadily increasing for many years, with an occasional exception, until 1914, when a diminished output is recorded, caused chiefly by conditions outside the country. Stocks on hand at the close of 1914 showed a decrease for the entire country amounting to 9%. In 1914 Florida, the leading state in the production of phosphate rock, marketed 2,138,891 tons, or 78% of the entire production of the United States. The Florida phosphate rock consists of hard rock, land pebble and river pebble. Exports amounted to 964,114 tons.

Car-Stop of Novel Design for Use in Yard Tracks

A car-stop which catches the wheels of cars instead of acting as a bumper has been applied by a number of railways, especially on stub tracks ending at streets or other points where it would be dangerous for a car to overrun the track. In the past a large number of very serious accidents have occurred at just such locations where the ordinary bumper had been installed.



CAR-STOP FOR YARD TRACKS

As shown in the accompanying drawing, it consists of two sets of castings forming a 15-ft. continuation of the track rails and having a series of concave depressions to engage the wheels. These castings are placed on 6x10-in. stringers, inclined to give a rise of 24 to 30 in. at the rear end. It would take very high speed to drive a car to the end of this device, and the raised end would then keep it from over-running. The depressions are about 29 in. c. to c., with a drop of 3¼ in. for the first two and 5½ in. for the others.

The car wheels ride on their flanges on the car-stop and the brakeshoes and rigging are carried clear of the ridges as shown in the section in the accompanying drawing.

The device is made by the Saunders Car Stopper and Equipment Co., 113 North 2nd St., St. Louis, Mo. The Southern Railway Supply Co., St. Louis, is sales agent.

Aerodynamic Experiments Made in M. I. T. Tunnel

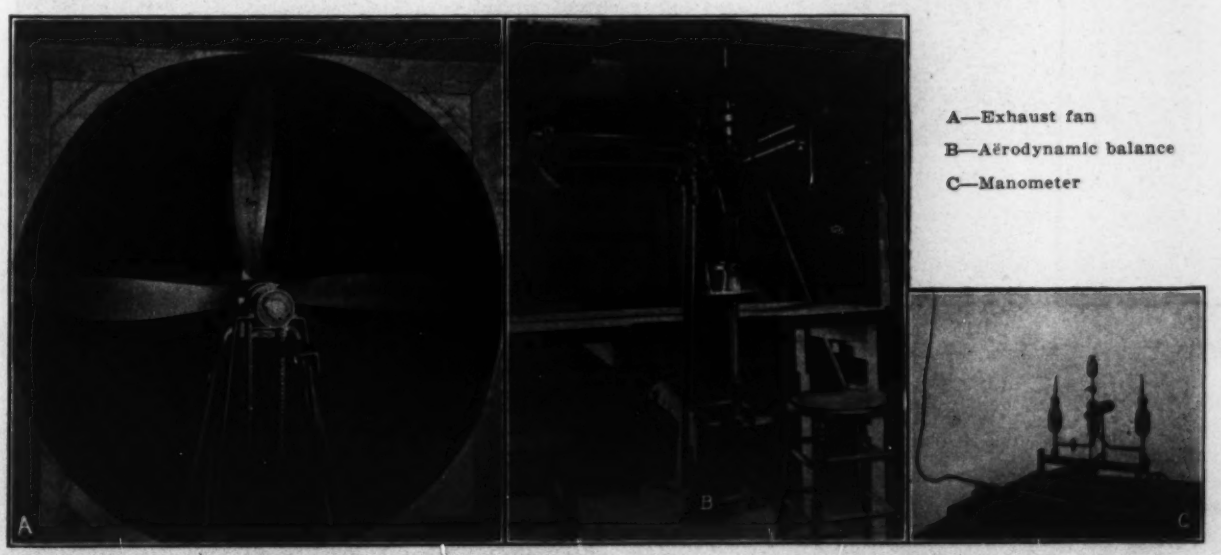
An aërodynamic laboratory for the study of the characteristics of air currents has been constructed and is the first building completed in the new group of the Massachusetts Institute of Technology at Cambridge, Mass. The laboratory consists of an inexpensive structure housing a wooden tunnel 4 ft. square and about 40 ft. long, through which air is drawn by means of a four-blade wooden propeller 7 ft. in diameter, revolved by a 25-hp. electric motor with chain drive. The flow velocities obtainable are as high as 35 mi. per hr.

The portion of the tunnel next to the fan is built of a sheet-metal cylinder, which diminishes in size toward the connection with the wood section. A wire grating is located just within the tube to catch any objects which might be drawn toward the fan, thus protecting the latter from injury. The mouth of the tunnel, at the opposite end from the fan, is fitted with horizontal tubes 12 in. long, to give direction to the air after it enters the tunnel.

Midway of the tunnel are planes for objects on which tests are to be made, and beneath this is located a balance which weighs three components—the forward push of the air on an object, the lift and the twist of air currents at varying velocities. This apparatus was manufactured in England on the pattern of one now in use at the National Physical Station at Teddington and was exhibited at the Royal Academy, London, before being sent to America. It is the only machine of its kind in this country. The accompanying views illustrate some of the details.

Pressure gages for tests of air pressures on objects in various relations under varying velocities can be placed at different locations in the tunnel, and experiments are being made with propeller blades for aëroplanes to determine their most efficient shapes.

The courses in aërodynamics at the Institute of Technology are given by the Department of Naval Architecture and Marine Engineering. The laboratory equipment and instruction are in charge of Lieut. J. C. Hansaker, U. S. N., who was detailed for this work.



A—Exhaust fan
B—Aërodynamic balance
C—Manometer

AERODYNAMIC LABORATORY APPARATUS AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE

Field and Office

Transferring Paving Materials from Cars to Pavement

During the summer and fall of this year a 6.1-mi. brick-paved country road was constructed from New Lexington toward Somerset, Ohio, under unusual conditions. The contractors succeeded in doing away with practically all hauling problems by building an extension of the Pennsylvania Lines alongside the roadway and bringing cement and brick direct from the manufactory to the job.

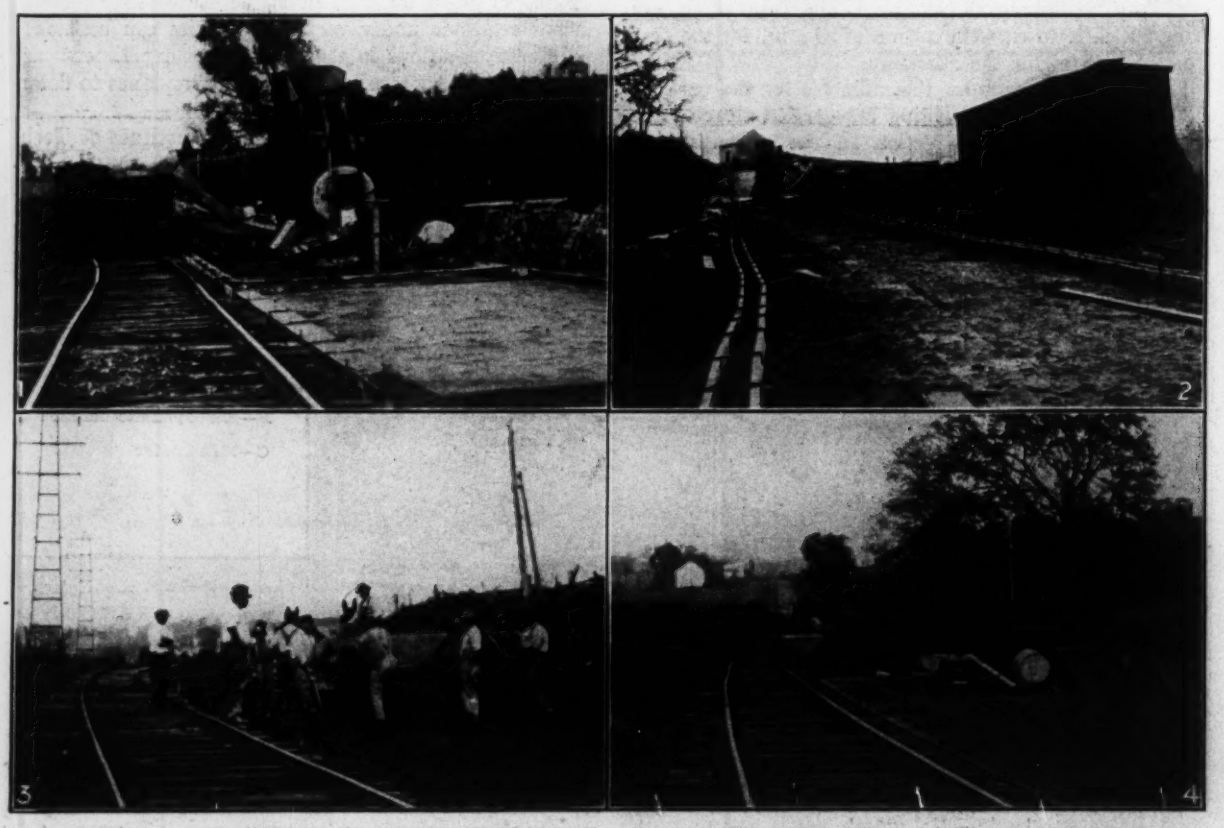
The pavement begins about 600 ft. from the union station of the Pennsylvania Lines and the Toledo & Ohio Central R.R. at New Lexington. Here the contractors' railway connects with the side tracks of the Pennsylvania Lines, and in the intervening 600 ft. between the main line and the beginning of the pavement a siding was built to accommodate three or four cars. This served as the contractors' sorting yard.

The new pavement follows the line of the old road. The soil is heavy clay. Before deciding on the construction methods the contractors came to the conclusion that teaming or motor-truck hauling was out of the question, and it was then that the decision was made to build a standard-gage construction railway.

The design called for a brick pavement 16 ft. wide with 5-ft. earth shoulders. It was determined to begin grading at once (last winter), and for this purpose a steam shovel was employed. As soon as pavement work could be begun in the spring, the whole force was employed laying track on the left-hand shoulder of the roadway. Old discarded ties and second-hand 60-lb. rails were used. When about ¾ mi. of track had been laid the paving work commenced.

The roadbed was finished to subgrade by hand shoveling and carting (Fig. 3), then rolled and the concrete base laid to the end of the track. The supply train for this stage of the work consisted of a box-car of cement on the forward end, a gondola car of sand and two gondola cars of gravel (Fig. 2). These were kept abreast or somewhat ahead of the Koehring paving mixer. The cement, sand and gravel were unloaded into wheelbarrows, the cement in bags and the sand and gravel through wooden chutes. One car of gravel was so spotted that this material could generally be discharged directly into the mixer hopper. Water for the mixer was pumped from small streams crossing the road and piped alongside the pavement on the right-hand side. A valve for a hose connection was placed about every 300 ft. on this pipe line.

It required considerable ingenuity to handle the cars correctly, for the contractor had but one locomotive (45-ton Shay geared), and a 6½% grade near the begin-



TRANSFERRING PAVING MATERIALS DIRECT FROM CARS TO PAVEMENT; ROAD AT NEW LEXINGTON, OHIO

ning of his track prevented hauling more than one car at a time on this part of the line, and there were no sidings other than the one at the beginning of the track. The four cars of material made about one day's work (600 ft. of 4-in. concrete base), so that cars could be shifted at night or out of working hours.

When the base was constructed to the end of the completed track, five or six carloads of brick were brought up and distributed at proper intervals. About this number of car loads was laid in a day. The brick were shipped in gondola cars, and to unload them, a shelf was hung by brackets to the side of the car. Two or three men in the car laid the bricks on this shelf. On the ground below, a two-step bench was laid parallel to the car. This permitted the men below easily to reach the brick on the shelf and to transfer them to the pavers. Fig. 1 shows a pile of brick at the side of the roadway, but this was the exception; they were unloaded during a wet spell to release a car.

The grouting was not done until the brick had been laid up to the end of the completed base. Then a grouting car was run over the line. This was a steel gondola. The sand and cement were mixed in the bottom of the car and transferred to a grout box on the pavement by a chute. The grouting was carried on continuously, the same crew working successively at the different operations.

The specifications did not limit the amount of brick laid before grouting the joints. The wording is: "Soon after the pavement has been properly compacted and surfaced, and before any dirt or other foreign material has entered the joints, they shall be filled with 1:1 portland cement grout."

When the pavement was completed, another ¾-mi. section of track was laid. Whenever possible the track construction work was done at times when the crew could not be employed on paving work. About five men were required as a permanent track gang, for, on account of frequent rains and subsequent washouts, the track required constant attention. Prompt and efficient operation of this little railway prevented the accumulation of demurrage charges, so that this item did not enter the cost.

The cost of the railway line on this job may be roughly estimated as follows: Rails, about $1,500 per mi.; ties (5c. for old ones, 30c. for new), about $1,000 per mi.; labor for track construction, about $550 per mi., and labor for removing track, about $550 per mi. The locomotive cost $4,500; but this could be considered a permanent investment. It is estimated that the cost of handling material was between 10c. and 15c. per ton-mile.

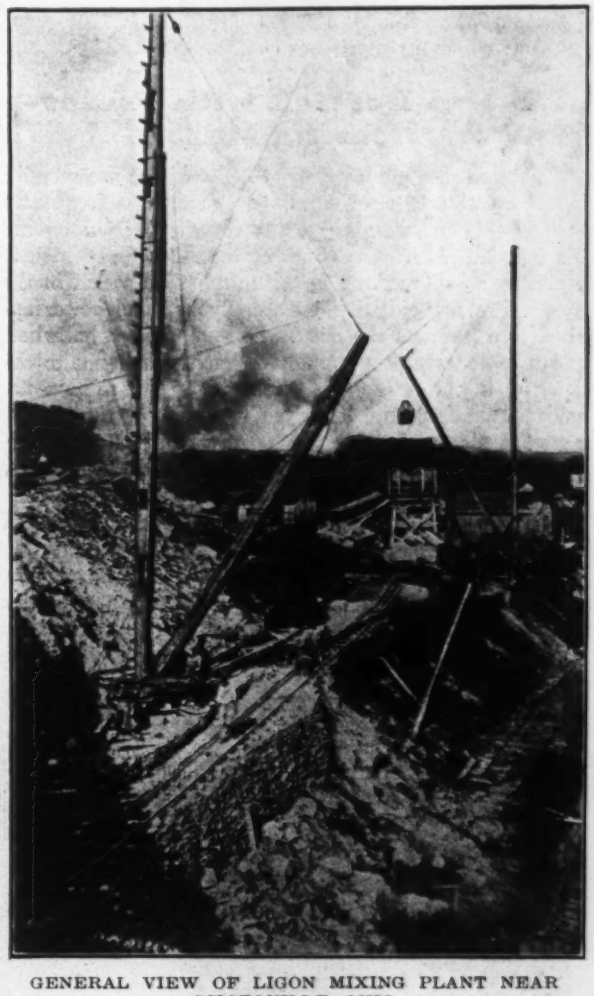
Aside from the economy in this particular case, it would have been nearly impossible to have hauled heavy loads on the soft shoulders and subgrade of the roadway. Moreover, no special outfit (except the locomotive) was required for hauling, and no special crew was employed on hauling work. When not moving the construction train there was always plenty of work for the locomotive, such as switching, spotting cars, etc. The variety of work to be done made it possible to keep the construction gang busy even during an exceptionally rainy summer, when on many days no paving work could be done.

The road was constructed under specifications of the Ohio State Highway Department, Clinton Cowen, Commissioner. The contractors were Swank & MacIntyre.

Mixer Supplies Three Jobs; Gasoline Dinkey Haulage

By H. B. Watters*

Gasoline dinkeys haul concrete cars at a speed of 40 to 50 mi. per hr. on long hauls from the mixing plant to the Little Scioto Viaduct on the new Chesapeake & Ohio Northern Ry. now building in Ohio. The mixing plant is located near where the line crosses over the main track



GENERAL VIEW OF LIGON MIXING PLANT NEAR SCIOTOVILLE, OHIO

and a siding of the Baltimore & Ohio Southwestern R.R., about 1 mi. east of Sciotoville, Ohio, and supplies concrete for the abutments of this crossing (3,800 cu.yd.), for a 20-ft. concrete arch (containing 1,000 yd.) for a highway undercrossing located about 1,000 ft. from the mixer and for the piers and abutments of the 1,080-ft. viaduct over the Little Scioto River. The viaduct footings contain about 6,000 yd. of concrete and are located 3,500 ft. north of the mixer.

The accompanying view was taken from a trestle thrown across the B. & O. S. W. Ry. on about the grade line of the new railway. At no point are the materials handled by hand, except in the case of the cement when it goes into the mixer. The gravel and sand are shipped to the site on the B. & O. and are unloaded by derrick

*Resident Engineer, Chesapeake & Ohio Northern Ry., Sciotoville, Ohio.

into hoppers placed directly above the mixer. The mixer is charged from the hoppers and the concrete is dumped into 1-yd. cars and taken to the viaduct and to the highway crossing by the gasoline dinkeys. The concrete is deposited in the forms by derricks or chutes. On the long hauls the concrete trains consist of three 1-yd. cars. C. Y. Ligon & Co. are subcontractors under Rinehart & Dennis. M. J. Caples is in general charge of the work for the C. & O. N. Ry. W. Michel is Chief Engineer. The writer is engineer on Residency No. 1.

20-Ton Derrick with Roller-Bearing Mast

The large steel guy derricks which are used so generally in the erection of steel buildings and bridges frequently give trouble in swinging because of the friction on the bearing which forms the foot of the mast, and which is generally a ball working in a hemispherical socket in the shoe. The swinging is done usually by hand power applied to a lever on the mast. In some cases a bullwheel and a cable have been employed, but the distance to the hoisting engine is so great that it is difficult to have the various signals promptly obeyed, especially as the engineman has also to operate the hoisting and luffing cables.

To eliminate this difficulty in erecting the steel framing for the William Penn Hotel at Pittsburgh, derricks with roller-bearing turntables for the shoe and head of the mast were designed by the Bergendahl-Knight Co., of Chicago, which had the contract for the erection. The derrick thus equipped was turned by one man, although ordinarily three or four men would be required with a derrick carrying a load. The derricks and bearings were built by the American Bridge Co. The bearings can be applied to old derricks.

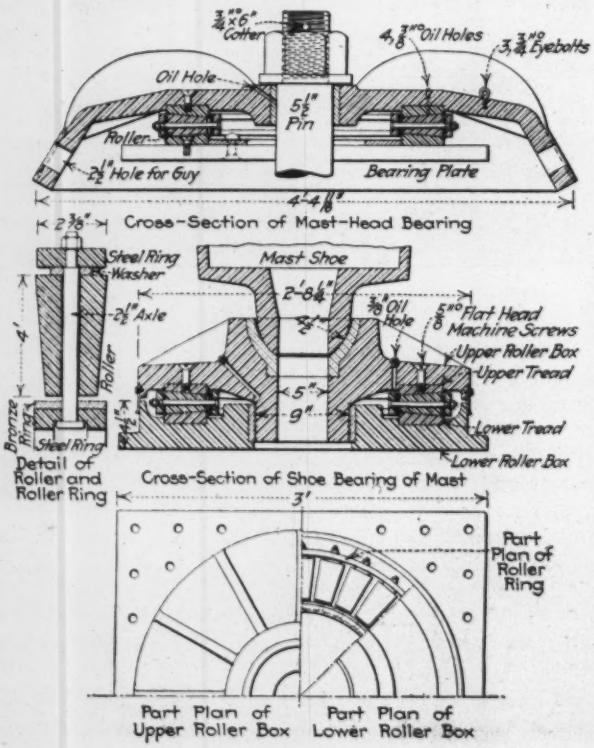


FIG. 1. ROLLER BEARINGS FOR SHOE AND MAST-HEAD OF 20-TON DERRICK

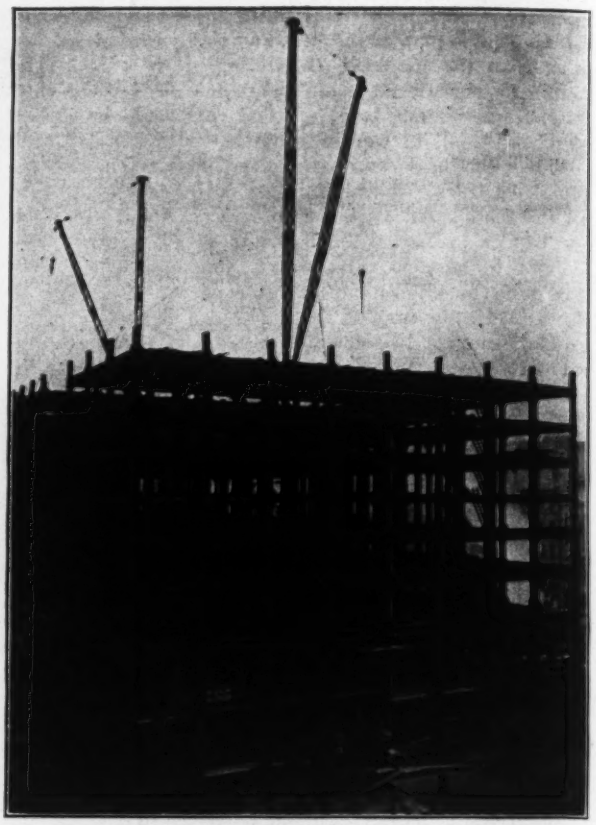


FIG. 2. TWO 20-TON ROLLER-BEARING GUY DERRICKS, WILLIAM PENN HOTEL, PITTSBURGH (101-FT. MAST, 90-FT. BOOM)

Roller Bearings for Derrick Mast

The mast bearings are shown in Fig. 1. The foot of the mast has the usual hemispherical foot, so that pressure on the roller bearing is centralized even if the mast is not exactly vertical. This bearing consists of two plates or roller boxes, with a live-ring of rollers between. The foot of the mast rests in a hemispherical bushing in the upper roller box, which has a stem fitted into a bushed socket in the lower box. This prevents any rocking of the upper box and keeps the two boxes concentric.

The roller boxes are steel castings (annealed) and have attached to them the tapered treads of tool steel. Between these are the 28 conical rollers, which are of die steel. The roller axles are carried in two forged-steel rings, with a bronze ring on the inner side and a bronze washer on the outer end of each roller. The roller boxes form an annular oil chamber, retaining oil up to the level of the axles, so that the rollers move in an oil bath. The opening between the outside edges of the two boxes is closed by a steel band which is secured to the upper box by screws. This excludes dirt. The design is very compact, as the bearing is only 3 ft. square on the base and 12 in. high.

The masthead bearing is of similar construction. The hood to which the guys are attached has a bushed bearing for the 5½-in. mast pin, and this hood forms the upper roller box, with the roller tread secured to it by screws.

The lower tread is carried by a 36-in. bearing plate bolted to a similar plate forming the cap of the mast. The rollers run in oil, as previously described. The hood has eight 2½-in. holes for the guys.

Other Features of the Derrick

The derrick has a mast 101 ft. high and a boom 88 ft. long, giving a horizontal reach of 90 ft. Both pieces have two 14-ft. removable sections (the four sections being interchangeable), and the splices for these are made with splice plates on four sides.

The mast and boom, Fig. 3, are of box lattice construction, with four chord angles, 4x4 in. for the former and

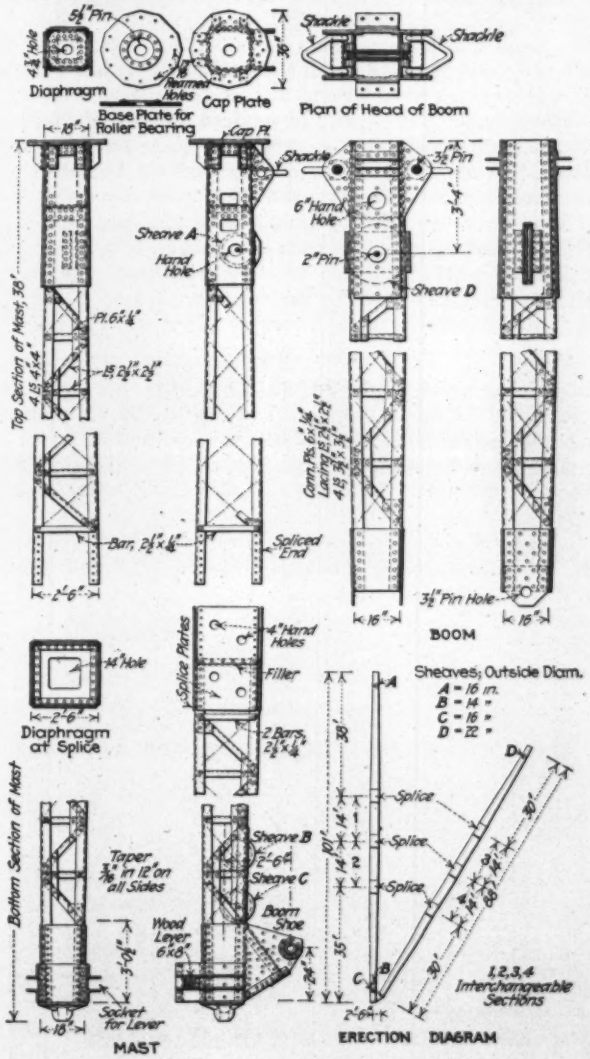


FIG. 3. 20-TON ROLLER-BEARING DERRICK

3½x3½ in. for the latter. The lacing angles are 2½x2½ in., with gusset-plate connections. A special feature of the design is the use of horizontal ties, which serve very conveniently as ladders for the use of the riggers. Across one side of the shoe of the mast is a pair of angles, between which is fitted the 6x8-in. oak lever for swinging the derrick.

The boom has its foot seated on a 3½-in. pin in the mast shoe and can be raised to a vertical position against the mast. Its head has a 22-in. sheave for the hoisting cable and two shackles for the attachment of the blocks for the luffing and hoisting tackle. The mast has two sheaves at the bottom, one for the ⅝-in. hoisting cable running to the head of the boom and the other for the ⅝-in. luffing cable, which runs over another sheave at the head of the mast.

The steel erection on the William Penn Hotel was done with two 20-ton derricks (one old and one new), as shown in Fig. 2. Both of these were equipped with the roller bearings described. On this work each derrick was served by a 50-hp. electric hoist installed in the basement. The two derricks erected about 9,000 tons of steel.

Two New Methods in Backfilling

Two novel schemes were employed to backfill a heavy reinforced-concrete river wall which is being built in Cedar Rapids, Iowa. In order to lay the foundations it was necessary to construct a coffer-dam in front of the site of the wall. This was of earth, and it is this earth that is being used to backfill the completed wall.

The Cedar Rapids river wall between the bridges at First, Second and Third St. was constructed by Frank K. Hahn, a local contractor. The work is carried on under the supervision of the River Front Improvement Commission, of Cedar Rapids, for which M. L. Fox is inspector.

A Homemade Ladder Conveyor

The muck is being elevated from the coffer-dam to the top of the wall by a ladder conveyor (see Fig. 1), made on the job by the contractor. Materials for its con-

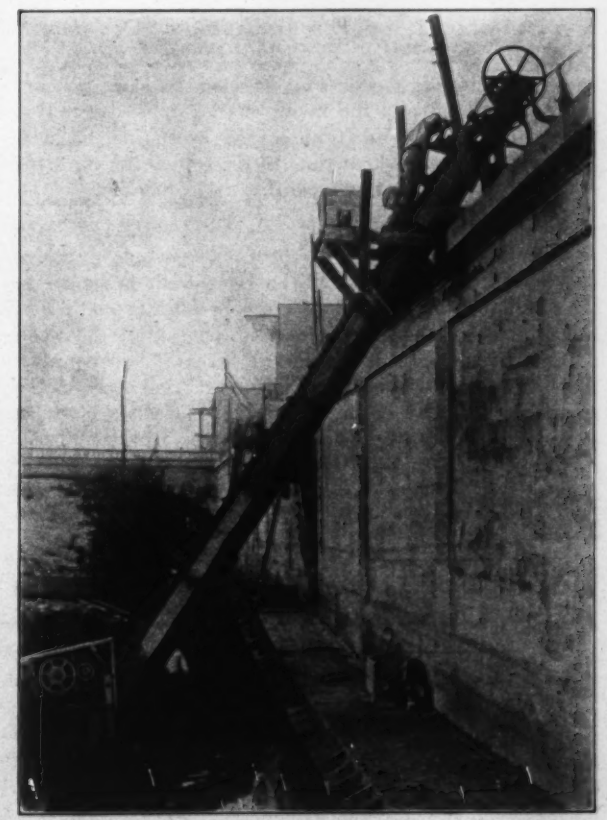


FIG. 1. HOMEMADE LADDER CONVEYOR IN POSITION FOR BACKFILLING

struction were obtained from the Link-Belt Co. and from the Quaker Oats Co., whose plant is in the city. The buckets are wide strips of metal which slide up a plank at an angle of about 60° with the plank and empty as they go over the sprockets at the top. A gang of men at the bottom of the conveyor fills the buckets by shovel. The material is mucky and does not readily empty from the buckets. Any muck which adheres to the

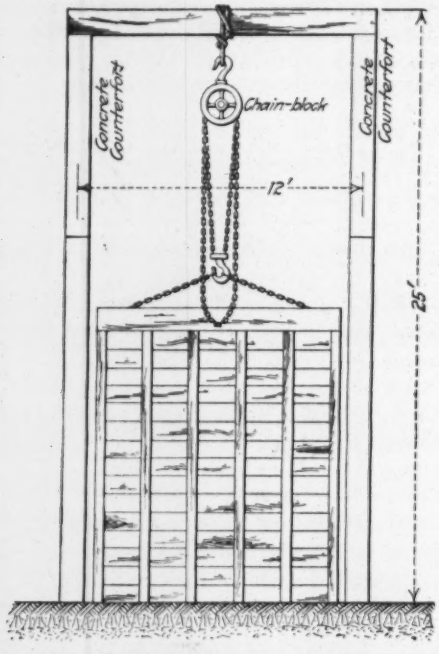


FIG. 2. WOOD APRON FOR RETAINING 6-IN. COBBLE BACKING DURING BACKFILLING

buckets as they go over the sprocket falls in a short chute, which delivers the muck on the upper section of the inclined plank in front of the ascending buckets. Thus all the muck which rises to the top of the conveyor eventually goes into the backfill.

Wood Apron Holds Cobble Backing

A wood apron, used in laying up loose-stone drainage backing at the land side of the river wall, is shown in the accompanying sketch. As the backfilling continues, the 6-in. cobble backing is carried up behind the wood apron. This apron is suspended between two counterforts, from timber beams laid across the tops of the counterforts. The apron is raised by a chain-block as the work proceeds. The stones for the drainage backing are transported in wheelbarrows along the top of the wall to a point above the apron, where they are dumped.

Load Test on Concrete Joists; Unexpected Results

By J. H. Byrd*

Load tests of a concrete-joist floor were made on two school buildings recently constructed in Kansas City, Mo., both of which have a wing to the plan shown by the drawing. The joists span 37 ft. clear between walls of common brick, 18 in. thick. The joists are spaced 28 in. on centers.

*Structural Engineer, Finance Building, Kansas City, Mo.

The design live-load on the floors was 90 lb. per sq.ft. The dead-load, consisting of concrete floor and plaster ceiling at 20 lb., slab 43 lb., metal pan and lath 2 lb. per sq.ft., and joist 131 lb. per lin.ft., totaled 120 lb. per sq.ft. The total live- and dead-load for which the floor was designed is 210 lb. per sq.ft., or 490 lb. per lin.ft. of joist, equivalent to a total load on each joist of about 18,000 lb. The test load was 180 lb. per sq.ft., making at time of test a total load on each joist of 25,900 lb.

In design the unit stresses adopted were: Concrete, 750 lb.; high-carbon steel, 18,000 lb. A moment factor of $\frac{1}{10}$ was assumed.

The test load was applied 51 days after concrete was poured. Six joists were loaded, a surface area of 14x37 ft. Sand was used as load. A cubic foot was weighed carefully and found to weigh 85 lb. (loose). A bin 14x37 ft. was made on the floor and 2 ft. of sand placed over the entire area, in four layers, to produce weights of 50 lb., 100 lb., 150 lb. and 180 lb. per sq.ft. The final weight probably exceeded 180 lb., due to packing by laborers in spreading the different layers.

Idlers were attached to each joist at midspan and deflection readings could be made at all times.

The allowable deflection for each load (test and dead added) was calculated by the formula

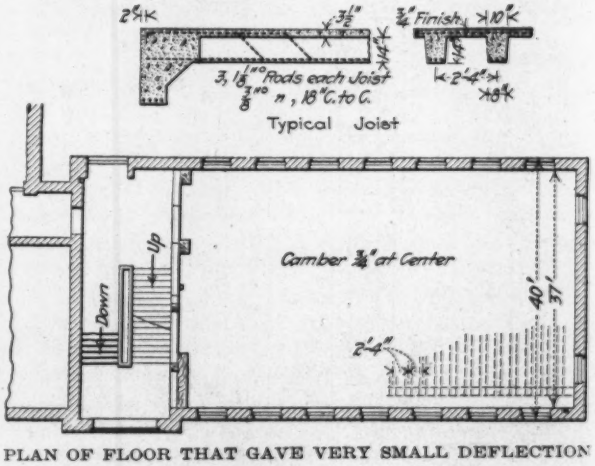
$$D = \frac{c_1}{E_s} \times \frac{W l^3}{b d^3} \times \frac{n}{\beta},$$

in which $n = 10$, $E_s = 30{,}000{,}000$.

If the deflection at any time had reached the calculated amount, no further load would have been applied.

Extensometer readings were also made on the steel to measure the actual elongation, and from these to calculate the stress.

The results of the readings up to the final load need not be stated. For the final load of about 26,000 lb. per joist



PLAN OF FLOOR THAT GAVE VERY SMALL DEFLECTION

the calculated deflection was 1.3 in.; the actual deflection was $\frac{1}{16}$ in. for three joists and $\frac{1}{32}$ in. for the other three.

The extensometer failed to show any movement of the needle, except by a reading glass, which showed too small a variation to record. A movement of one space ($\frac{1}{16}$ in.) would have indicated a stress of 300 lb. per sq.in. in the reinforcing steel.

Two points of design probably produced the small deflection shown. The first is the large belt of concrete at the walls, forming a deep and rather strong beam in the horizontal plane; in loading the center 14 ft.

of the floor, any thrust due to elongation would be resisted by this beam, fixed at the ends by the slab not loaded. The second point is the ¾-in. camber, forming an arch. In order that this arch may straighten out, a movement at the end is necessary, and the beam resists this movement. The arch action also would relieve the tension in the steel, probably accounting for the low unit stress in the steel.

Smith, Rea & Lovitt, of Kansas City, were the architects, and the author was structural engineer.

Large-Sized Soft Stone for Bituminous Macadam

The usual specifications for bituminous-macadam pavements limit the size of the stones composing the surfacing material to a maximum that will pass a 2½-in. ring. These specifications have given satisfaction with trap rock and granite, but with softer varieties of rock such as limestone there is a tendency for the stone to powder and crush under the roller and to wear under traffic, which makes a larger-sized aggregate desirable.

To meet these conditions the Ohio State Highway Department (Clinton Cowen, Commissioner) has been experimenting with the use of a surfacing stone that will pass a 4-in. ring and be retained on a 2½-in. ring. The voids in this material are partly filled with sand, stone dust and chips, although thorough rolling ordinarily breaks up enough of the material to make a fairly compact layer.

SURFACING AN OHIO STATE ROAD WITH 4-IN. STONE

The method of construction is to spread and harrow the stone as for a waterbound macadam road. As soon as the stone is partly compacted, stone chips and stone dust are spread into the voids with shovels. Rolling and the application of screenings are continued until the layer of stone is thoroughly compacted and the voids sufficiently filled so that the amount of bituminous material to be used will produce a dense mixture. The bituminous binder is applied by the penetration method with any approved form of apparatus.

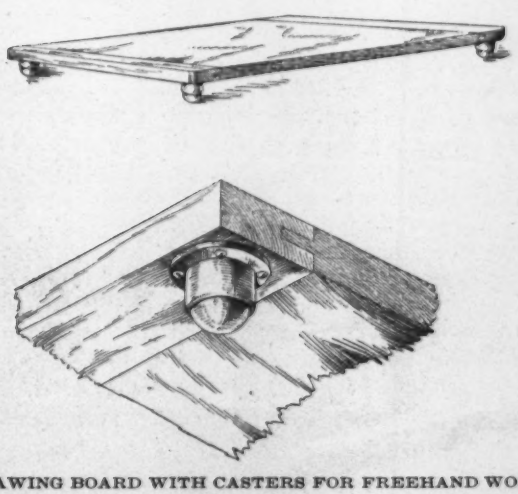
For pouring by hand, common sprinkling pots with the seams and connections riveted instead of soldered and with the holes in the nose punched to approximately ⅛ in. diameter are used. By filling the pots to nearly the same level each time and by taking care to cover about the same area with each potful, a uniform distribution is secured.

After the application of the bituminous binder the surface of the pavement is spread with screened washed gravel ¼ to 1 in. in size. After rolling the gravel in, a seal coat of the same bituminous material is applied and more gravel is added, followed by more rolling. A total application of about 2 gal. per sq.yd. for a 3-in. depth of rolled stone gives excellent results. Washed gravel instead of limestone chips is used, as the available gravel is usually harder and tougher than ordinary limestone and the cost is about the same. A finer gravel, ¼ in. to ⅝ in., is preferable for the seal coat. For a 4-in. road the amount of bituminous binder required is about 2¼ gal. per sq.yd.

According to A. H. Hinkle, Deputy State Highway Commissioner in charge of maintenance, from whom the foregoing information was obtained, these pavements have given much better satisfaction than the older ones that were constructed with the 2½-in. stone as aggregate.

NOTES

Ball-Bearing Drawing Board for Freehand Work—In making freehand drawings the board must be turned and shifted frequently to accommodate the hand to different curves and lines. I provided my board with four ball casters, as sketched,



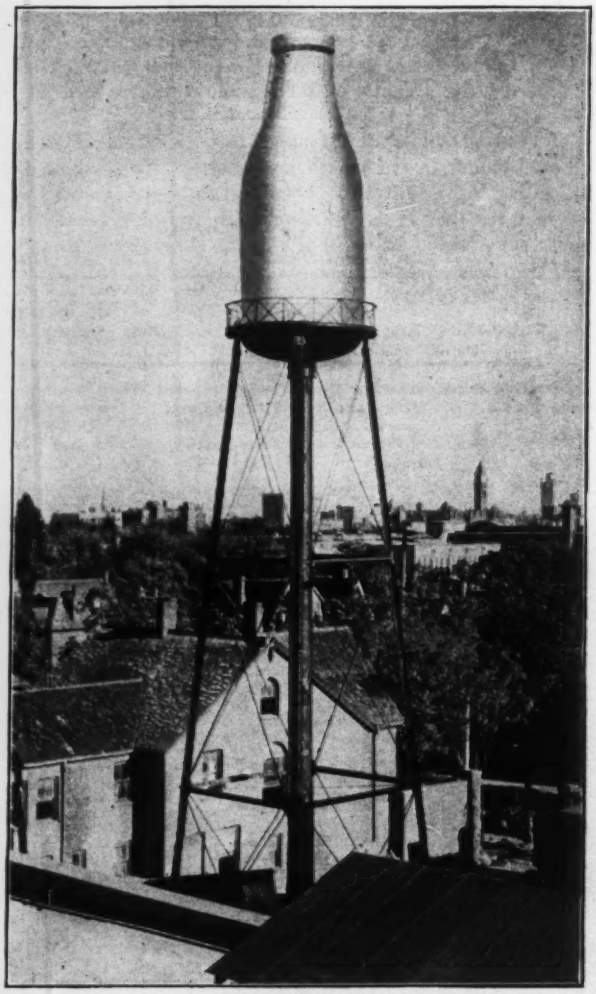
DRAWING BOARD WITH CASTERS FOR FREEHAND WORK

to facilitate this turning and shifting. The casters are a standard article, readily bought anywhere. I found this board very valuable for freehand work.—E. Schwartz, Brooklyn, N. Y.

Iron Washers as Form Spacers—To carry lighting-wire conduits the proper distance above the floor forms, ordinary iron washers are being used on the concrete buildings for the new cotton terminals at Atlanta, Ga. These washers are merely strung along the conduits at intervals and allowed to rest as they will on the forms.

A 75,000-Ton Blast was recently made in the limestone quarry of H. Frazier, Fort Spring, W. Va.—that amount of stone being thrown down by a single explosion. Some notes on the blast are given in the "Du Pont Magazine" for December. The height of the quarry face varies from 15 to 175 ft. Early in September thirteen 6-in. drill holes were put down 125 ft., extending 5 ft. below the quarry floor. There were also two short holes—72 and 85 ft. deep. The holes were about 15 ft. apart. In each hole was loaded about 500 lb. of 60% blasting gelatin and from 150 to 600 lb. of quarry powder. In each hole was a line of countered cordeau carrying one electric blasting cap. In 10 holes the charges were split near the center, with from 10 to 20 ft. of clay stemming between the charges and 20 ft. of clay stemming on the top charge. In the five holes which were loaded solid there was 30 ft. of clay stemming on top. About 50% of the stone thrown down was broken to one-man size. None was thrown over 100 yd. from the face. The total charge of explosives was 13,500 lb. The volume of loose rock was 60,500 cu.yd. The cost of explosive and blasting supplies was $16,040. The cost of drilling and loading was $820. The total cost of bringing down the rock was 3.3c. per ton.

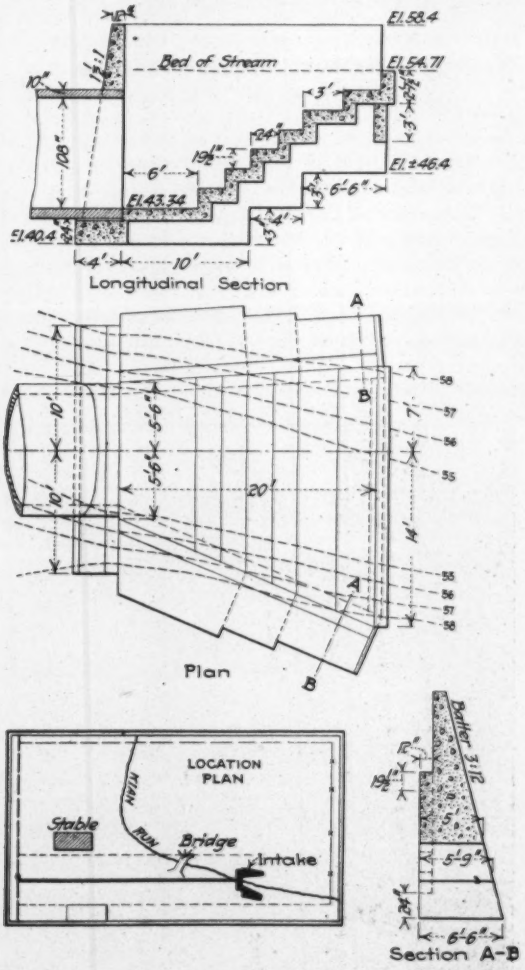
A Milk-Bottle Water Tank—The City Dairy Co., of Toronto, Ont., Canada, has at its plant a huge milk bottle, 70 ft. above ground, which is not a milk bottle at all, but an elevated tank for fire protection. This novel tank has just been



WATER TANK ADVERTISES BUSINESS OF CANADIAN DAIRY

completed by the Canadian Chicago Bridge and Iron Works, of Bridgeburg, Ont., and Chicago, Ill. The bottle is 13 ft. in diameter and 39 ft. 9 in. high and thus its top is about 105 ft. above ground. The exterior is painted white to carry out the idea of a milk bottle more perfectly. The bottle shape is formed by the steel plating of the tank itself; the rivet lines show plainly although they disappear in making the reproduction from the photograph in the cut herewith. The tank bottom is of the now much used ellipsoidal form. The tower is a standard four-post steel tower. Ellipsoid, tower and gallery being painted a different color from the bottle, in contrast with the white, heighten the illusion.

A Sewer Intake on a Running Stream forms the head end of the south-side storm sewer at Columbus, Ohio. One of the chief purposes of the sewer is to intercept a creek known as Kian Run, which now meanders through the southern part of the city, and to conduct it in a direction practically at right angles to its former course by a shortcut to the Scioto



STORM-SEWER INTAKE TO INTERCEPT KIAN RUN, COLUMBUS, OHIO

River. The intake opens into a 108-in. circular concrete sewer. The details of the intake are shown in the accompanying illustration. All concrete for the intake is 1: 2½: 5 mix, broken stone or gravel. Tongue joints 4x8 in. are placed at the junctions of the head and wing walls. The lump-sum contract price for this intake is $750. Henry Maetzel is City Engineer of Columbus, and the contractor is the J. C. Carland Co., Toledo, Ohio.

Nineteen-Year-Old Paint—Nineteen years ago Frank C. Hooper, manager of the North River Garnet Co., North River, Warren County, N. Y., became convinced that painting the wooden buildings of his plant every couple of years could be eliminated by a change of paint, reports "Graphite"—the house organ of the Dixon Crucible Co., of Jersey City. Therefore Mr. Hooper made the experiment of using a silica-graphite paint on the mill, outbuildings and a few workmen's cottages. To relieve the dark appearance of the natural graphite gray, the trimming coats were lightened with white lead. The surfaces are reported in "excellent condition" today, although no repainting has been done, and five of the cottages were moved to another plant 5 mi. away.

Editorials

Economy in Gravel Roads

Assuming the cost of a modern country-road pavement of the so-called "permanent" type at $15,000 a mile (conservative) and supposing this to be paid for by 20-yr. bonds at 4½%, the annual charges for interest on and redemption of the bonds amount to about $1,150 per annum. It is safe to assume that even the most "permanent" type of country-road pavement will require repairs and maintenance of at least $50 per mile per year, or in round figures we have a minimum of $1,200 per mile per year as the cost of the improved road.

Assuming that a good gravel road may be built for $4,000 per mile (which has been the average cost of New Hampshire roads), the annual charges for interest on and redemption of bonds (if the roads are built by bond issues) at the end of 20 yr. would amount to about $310. Therefore it is theoretically economical to spend nearly $900 per mile per year for the maintenance of gravel roads if for that sum the roads can be maintained in a condition equal to a pavement in the $15,000-a-mile class.

No one of course believes that a gravel road can everywhere be used as a substitute for a pavement, no matter how much money is spent for maintenance. But under favorable conditions it is more economical to spend a considerable sum on gravel-road maintenance than to invest large sums in pavement construction. The experience of New Hampshire and Vermont has proved this and has demonstrated that a properly cared for gravel road has a much larger capacity for motor-vehicle traffic than has been the generally accepted theory. An article on another page describes the maintenance of gravel roads by the State Highway Department of New Hampshire, where at an annual cost of from $250 to $600 a mile plain gravel roads have been kept in perfect condition under a motor-vehicle traffic of from 800 to 1,000 cars a day.

Even the most enthusiastic gravel-road advocate recognizes that gravel roads will not stand up under exceptionally dense or heavy traffic. There are plenty of roads in New Hampshire near the larger cities and towns where some form of pavement has been found most economical. Moreover, it must be borne in mind that the New Hampshire roads carry a dense traffic only during a part of the year; but on the other hand they are under patrol maintenance only for about the same length of time each year. They are good roads all the year round and exceptionally fine motoring roads in the summer.

Similar conditions exist in other localities. In a great many cases the severe traffic is only during the summer season, and to build an expensive pavement to take care of summer tourist traffic is not economical when half the amount of annual interest charges on such an investment would keep a gravel road in splendid condition.

The plain gravel roads of New Hampshire and Vermont are object lessons in economical roadbuilding and maintenance, and the traffic they are carrying is a convincing refutation of some elaborately worked out theories as to the wearing qualities of plain gravel roads.

Another Novel Quay Wall

The quay wall for the new deep-water terminals at Halifax, described on another page of this issue, is a remarkable structure both in size and design. Retaining walls 60 ft. in height are scarce enough in land structures where every opportunity for construction in the open is afforded. In sea walls they are even more rare. The Halifax design, however, is unique, and in these days of increasing novelty in pier and quay-wall design that is saying a good deal.

As pointed out in the article, the combination of a rock bottom with no overlying earth and the great depth required eliminated all but two types of wall, the cyclopean block, either of cast concrete or masonry, and the hollow reinforced-concrete caisson which could be cast in dry dock or on marine railway and floated to place, there to be sunk and filled with concrete or rock. The former method is time-honored; it is, however, most expensive and involves many difficulties in the placing and effective joining of the blocks. The latter method, of somewhat recent origin, has had a great vogue and almost unbroken success. For so extensive a work as that at Halifax it would require an enormous plant or else an unduly long time, for the construction of one of these big hollow boxes is an engineering operation of magnitude requiring considerable space, material and plant. Furthermore, the founding of such a box on a rock bottom, even though that bottom has been prepared by diver or in diving bell, is a ticklish undertaking. With the removable wooden bottom, as introduced in the Ontario entrance to the Welland Canal, this difficulty is reduced from what it is in the older solid-bottom caissons, but that method even is better adapted to the soft bottom where a preparatory foundation of riprap can be laid.

In lieu of these two alternatives the Canadian Government engineers have devised a new scheme that is a judicious combination of the benefits of the separate block and the hollow box and is sufficiently novel probably to insure its patentability, if its inventors so desired. The general method of deposition of the separate block is combined with the shape and method of manufacture of the hollow box. On paper the scheme appears formidable; in fact, some of the contractors contemplating the work were scared by its possible complications. In practice, on the contrary, it is working out in admirable fashion, and in the limited progress so far made has reflected credit on both its designers and executors.

Hoarded Water Rights Freed by Morris Canal Decision

The monopoly of the available sources of public water-supply for a considerable portion of northeastern New Jersey which has been attempted with more or less success for three decades now seems to have met a serious check but one which would have been much more beneficial to

the public interests had it come years ago. The check comes from the decision of the United States Supreme Court on Nov. 15 in Morris Canal and Banking Co. and Lehigh Valley R.R. Co. vs. New Jersey State Board of Assessors. The possible liberation of hoarded water rights is not obvious, for primarily the case involved the right of New Jersey to tax the Morris Canal, which stretches across the state. To see the further effects of the decision, a little of the history of the case must be set forth.

When the Morris Canal and Banking Co. was chartered in 1824 it was exempted from state and local taxation so long as its property was used for "canal navigation." In 1871 the company was authorized to lease its property and franchises, but no mention was made of the taxation-exemption grant from the state. A few weeks later the canal company leased its canal and accessories and sold its personal property to the Lehigh Valley Railroad Co. In 1884 and subsequent years the legislature provided for the taxation of railroads and canals. The state tax on the canal property for the year 1906 was contested by the owners on the ground of the exemption clause in the charter of 1824, but the contention was denied by the New Jersey Court of Errors and Appeals. This decision is now upheld by the United States Supreme Court, which points out that the statute of 1871 did not authorize the transfer of exemption from taxation, and adds: " . . . as clearly pointed out in the Rochester case, Rochester Railway Co. vs. Rochester, 205 U. S. 236, an exemption from taxation does not pass under a valid lease or sale of corporate property together with appurtenances and franchises."

The original rights were granted for navigation; but under color of rights to water for that purpose, the attempted water monopoly has been selling water rights and water itself for municipal purposes and declaring "hands off" to all others who claimed or sought a right to certain waters. Had such a decision as this been handed down in 1885 instead of 1915 it might have had a material bearing upon the Newark, Jersey City and other water-supply contracts; particularly on the long controversy over the Jersey City contract. Even now the decision may have a material bearing upon the efforts of the State Water-Supply Commission and the State Conservation Commission to control some of the potable waters of the state.

Also, beyond guaranteeing to the state hundreds of thousands of dollars in taxes and aiding it regain a control of its potable waters which it should not and need not ever have lost, the decision will doubtless hasten an equitable settlement of the long contest over the abandonment of the Morris Canal. This will mean much to the state and to the municipalities and townships through which the canal extends and may contribute materially to success in converting the canal into a water parkway, advocated with much earnestness for several years past.

Finally, the broader bearing of this decision should not be overlooked. Taken with the Rochester decision already mentioned, it may aid other states and perhaps scores of cities to regain control of water-supplies and waterfronts granted explicitly for beneficial public use and which should revert to the state when not used for the purpose of the grant, but which have been diverted to quite other purposes, to the enrichment of private and the robbery of public interests.

The Panama-Pacific Exposition Comes to an End

At midnight on Dec. 4, the Panama-Pacific Exposition closed its gates for the last time, having been open to the public for 288 days. It has been widely advertised that the Exposition has yielded a profit of $2,000,000; but this means only that the receipts from paid admissions, concessions, etc., exceeded the running expenses of the fair by that amount during the time it was open. The cost of creating the fair—grounds, buildings and all—was to the Exposition company about $17,000,000. When to this are added the amounts spent by exhibitors, concessionaires and others, the current statement of $50,000,000 as the total outlay on the Exposition is probably not excessive.

The total number of admissions is stated to have reached 17,000,000 on Nov. 19; but this included apparently the daily admissions on passes of several thousand attendants and employees. Allowing for this and for the fact that most of those who visited the Exposition went on the grounds from three to a dozen times or more, it is probable that not more than two million different persons visited the Exposition.

That it was worth a great deal to have such a wonderful display of art and architecture and constructive genius as the Exposition spread before two million or more people, every visitor who had the privilege of seeing it will agree. The exhibits themselves were creditable, but what every visitor to the Exposition will longest remember was its success as an artistic creation. The buildings at San Francisco in their proportions, their decoration and particularly in their coloring and their night illumination surpassed even the well-remembered successes at the Chicago Exposition of 1894 and the St. Louis Exposition of 1904.

The toast sent by President Wilson for the exercises at the close of the Exposition declared that "in its conception and successful accomplishment the Exposition gave striking evidence of the practical genius and artistic taste of America." The engineering profession may well take pride in the fact that the Exposition was the creation of engineers, and its success was the greatest demonstration ever made that a competent engineering executive can so direct the work of artists, architects and constructors as to produce a finished masterpiece.

United States Supreme Court on Invention and Design

Attention was called in these columns last week to the difference between the work of the inventor and the work of the designer in connection with a court decision recently rendered on certain reinforced-concrete patents. It will be of interest to many to read an authoritative opinion on this question from the highest court in the land. A correspondent has sent an extract from an opinion rendered by the Supreme Court of the United States, delivered by the late Justice Bradley, in the case of the Atlantic Works vs. Brady, 107 United States, 192. The extract is as follows:

The process of development in manufacture creates a constant demand for new appliances, which the skill of ordinary head workmen and engineers is generally adequate to devise, and which indeed are the natural and proper outgrowth of such development. Each step forward prepares

the way for the next, and each is usually taken by spontaneous trials and attempts in a hundred different places. To grant a single party a monopoly of every slight advance made, except where the exercise of invention somewhat above the ordinary mechanical or engineering skill is distinctly shown, is unjust in principle and injurious in its consequences.

The design of the patent laws is to reward those who make some substantial discovery or invention which adds to our knowledge and makes a step in advance in the useful arts. Such inventors are worthy of all favor. It was never the object of those laws to grant a monopoly for every trifling device, every shadow of a shade of an idea which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufacture.

Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvement and gather its foam in the form of patented monopolies, which enable them to lay a heavy tax upon the industry of the country, without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of concealed liens and unknown liabilities to lawsuits and vexatious accountings for profits made in good faith.

It may freely be conceded that this rule, laid down by the Supreme Court in this and other decisions, has often been trangressed, not only by the Patent Office in the granting of patents, but by the lower courts in adjudicating them. It will not do, however, to blame too seriously the judges who have erred in sustaining patents on trivial combinations and assemblages involving no real invention but merely an attempt to monopolize some next step in mechanical or engineering progress. For such prostitution of the patent system, patent attorneys and patent experts are probably even more at fault than the judges themselves. There is little wonder that the judges, with only laymen's knowledge of technical matters and unable to secure the advice of unbiased experts, are often mystified by the great mass of technical details which are presented to them by the attorneys and experts on opposite sides. It has often happened, moreover, that in a patent case each side is desirous of sustaining the patents in controversy, and there is no one to present the side of the public, which is interested in having patents annulled if they create a monopoly in what should be public property.

It is quite possible that the investigation which has been ordered by a Senate committee may lead to radical reforms in the granting of patents and in patent litigation.

Contrasts in Port Development

The current export-freight congestion in New York and, in a lesser degree, in other Atlantic ports makes of especial interest the very elaborate port improvement at Halifax now being made by the Canadian Government. While the main cause of the present congestion is of course scarcity of ships, there is no disputing the fact that a secondary influence is the primitive terminal facilities available at most American ports. The Halifax improvement will make it without doubt the most modern port development on this continent; its design and execution leave very little to criticize. When completed it ought to bring down terminal costs to somewhere near their proper relation to transportation costs, in contrast to the usual condition in most of our ports.

In contrast, too, to the situation in American ports, the problem at Halifax is being worked out in its entirety under one directive head, subject only to the vicissitudes of future political change in the national government, whereas in the United States the management of a port is likely to be entirely changed every time a change occurs in the city government. One need only note the past history of port-improvement projects in Boston or view with a prophetic eye the coming port policy of Philadelphia to understand the contrast. The much-heralded Port Commission appointed by the New York City Board of Estimate and Apportionment is as yet only a name because the same Board has omitted to appropriate any funds for the Commission to work with.

And yet, notwithstanding their excellent design and construction it is within the possibilities that these great Halifax terminals may find as little use as some of the loudly exploited municipal piers at minor ports of the United States. The most efficient terminal in the world cannot create commerce, and it remains to be seen whether the influence of the Canadian Government plus the low terminal charges at Halifax will be sufficient to offset the long railway hauls from manufacturing and farming centers to that port. It is quite possible that Montreal and Quebec in the summer and Portland, Boston and New York in the winter will continue to get most of the Canadian export business.

Letters to the Editor

Origin of Compressed-Air Tunnel Ventilation

Sir—In the mammoth workings of the famous Comstock Lode, at Virginia City, Nev., were initiated many of the practices that have been developed into systems. The nature of the rock in that locality and the great depth of the workings generated extreme temperatures when the rock was exposed to the air. This made it necessary to introduce quickly into the faces of the extreme workings fresh, cold air in sufficient volume to sustain the almost naked and sweat-smothered miners working in short shifts or reliefs.

Power rock drills driven by compressed air were first extensively used in mining and tunneling in the Comstock Lode. True, such machines had been employed in the Hoosac Tunnel in Massachusetts and in another driven in Pennsylvania, but they were so heavy and cumbersome, requiring ponderous carriages for their mounting, and mechanically were so defective that as economical factors in tunneling they had given little if any advantage over hand drilling. Later they were modified and made more adaptable, and their practical worth was first demonstrated in the Sutro Tunnel driven to tap the Comstock Lode at depth to drain it of water and permit transportation of the ores to the mills near the tunnel's mouth.

Smaller machine drills adapted to the mine drifts came to be quite generally used in the workings of that lode, and the compressed air with which they were driven, exhausting from them into the extreme headings and expanding to four or five times its volume and thus being rendered very cold, supplied the miners with ample fresh, cold air and a ready and admirable means of ventilating the workings.

From this Comstock Lode practice has developed the system of tunnel ventilation by compressed air now generally employed. But its growth was slow and roundabout. In fact the resumption of this local practice with compressed air and its development in large tunnel work were taken up many years later, after steam exhausted from power drills had proved to be more or less a success in such work.

Steam-exhaust ventilation was first demonstrated by a Colorado miner whose name I do not recall. With one power drill driven by steam, he ran a small mine tunnel 1,000 ft. into a mountain and ventilated it by utilizing the exhaust steam from his machine in the following manner:

Near his steam boiler, at the mouth of the tunnel, he set up a wooden box chimney connected at the bottom to a similar horizontal box which ran in near the face of the heading. Into the end of this flue he set up a wide-mouthed funnel, which was removed before blasting. By opening a ¼-in. steam jet in the chimney after a blast, he caused a strong suction to draw the foul air into the inner end of his ventilating box. This in no long time so cleared the extreme heading that he went in, set up his funnel and machine and went to drilling, carrying the exhaust steam through a hose into the funnel. The exhaust was sufficient to maintain the draft, and the live-steam jet in the chimney was shut off. This device kept his tunnel filled with a flow of fresh air and his heading comfortably cool. This worthy adventurer took righteous pleasure in writing me of his success with steam against my expressed belief that he could not make it work successfully in tunneling.

Years later, on one of the several railway tunnels that were undertaken on the South Penn Ry. to run between Harrisburg and Pittsburgh, the contractors started using steam for driving the drills until air compressors could be built and installed. On getting in a distance, the steam from the machines uncomfortably raised the temperature. The Colorado miner's device recurred to my mind, and it was introduced, where some seven drills were in operation. It ventilated the tunnel while it was being driven in some 800 ft.

Years after the South Penn work, the Croton Aqueduct Tunnel for the supply of water to New York City was underway. This 36-mi. tunnel was the longest that had ever been undertaken. In the center of every 3,000 ft. section a shaft was sunk to grade, and tunnels were driven north and south from this, each 1,500 ft., until they met opposite headings. Extensive ventilation was necessary, and this was foreseen to be very expensive unless some method other than by the usual exhaust fans or blowers could be devised.

I had equipped half of the tunnel, under contract with Brown, Howard & Co., with Ingersoll drills, air compressors, boilers, etc., and was in constant consultation with D. D. McBean, of that firm, the manager of the work. When the matter of ventilation came up, Mr. McBean was in no way disposed to go into the large expense of equipment with known appliances if this could be obviated—and he was not the man to permit difficulties of any nature to prevent the employment of simple and effective means. On his hearing of the success of compressed air in the Comstock heading and steam exhaust in the Colorado mine and the South Penn Ry. tunnel, he decided to try them in his work on the Croton Aqueduct Tunnel. They were successfully adapted. This was the first development and use of the since well-known system of compressed-air ventilation for large tunneling operations. The features of this system and its details have become too well known to warrant mention here.

Up to that time, as president of the Ingersoll Rock Drill Co., I had furnished the mechanical equipment for seven-eighths of the railway and other large tunnels that had been made using power drills, and was therefore in a position to know what appliances had been tried or used. To the best of my knowledge this is the history of the rise and development of this system of tunnel ventilation. F. M. PIERCE.

Point Loma, Calif., Nov. 11, 1915.

Track Maintenance

Sir—The insufficiency of track forces is given by Mr. Schlesinger in your issue of Nov. 11 as the cause of defective track. But no track force can maintain good track with rotten ties, insufficient ballast, light and worn rails and old or defective fastenings, especially when these conditions occur on track with at least moderately heavy traffic. The accident reports of the Interstate Commerce Commission inspectors indicate the existence of track of this kind, although of course it is exceptional.

RAILWAY.

A Sewage-Disposal Problem

Sir—I have bene asked to assist in the design of a plant for the disposal of sewage consisting of house waste from some 50 to 70 persons and the liquid waste from stables sheltering about 700 head of cattle. It has been assumed that the sewage from the domestic buildings and stables may be satisfactorily treated by customary methods, selected, however, to suit the composition of the sewage. As the problem seems to be unusual, the experience of others with similar problems, if such there be, would be appreciated. UNUSUAL.

Cowstables, Dec. 1, 1915.

[The problem presented seems to be properly characterized as unusual, but as announced two or three thousand years ago, there is nothing really new under the sun. Information regarding how similar problems have been met and solved would be of interest to many readers and of practical value to a considerable number besides the inquirer.—Editor.]

The Influence of Manufacturing Industries upon the growth of population is illustrated by a census just taken of two villages in the suburbs of Detroit. St. Clair Heights, Mich., has a population of 6,853, an increase of 447% since 1910. Highland Park, Mich., has a population of 27,155, an increase of 559% since 1910. The remarkable growth of these villages is chiefly owing to the automobile manufacturing industry in and near them.

Chicago Smoke Abatement and Railway Electrification

A brief summary from an advance statement concerning the report of the Chicago Railway Electrification Commission was printed in *Engineering News*, Nov. 25, p. 1024. The complete report of the commission was submitted on Dec. 1. As previously announced, the commission finds that the electrification of Chicago railways as a whole, while an engineering possibility, would involve an enormous cost wholly beyond the means of the railway companies to raise.

Five years ago the Chicago City Council passed an ordinance requiring the railways after a certain date to use some other motive power than steam locomotives to operate their trains within the city limits of Chicago. Public opinion was in a confused state concerning this ordinance, and with a view to determining the facts in the case the Chicago Association of Commerce appointed a commission of 17 citizens to investigate the whole subject and report. A large engineering organization was created headed by the late Horace G. Burt, former president of the Union Pacific R.R. After Mr. Burt's death in May, 1913, he was succeeded by Dr. W. F. M. Goss, Dean of the Engineering School of the University of Illinois.

Air Pollution and Smoke Prevention

A vast amount of matter has been published concerning the causes and effects of smoke in cities. The commission's investigations showed that nearly all this published matter is of very doubtful reliability, being based on general impressions rather than scientific data. The commission found, for example, that greater harm to the health of city dwellers is done by the invisible products of combustion, such as sulphurous gas and fine mineral dust, than by the visible smoke. While two-thirds of the pollution of Chicago air is due to the combustion of coal, the other third is due to dust, gases, etc., from other sources, so that even if all combustion of coal were eliminated, considerable pollution of the air would remain. The smoke polluting the air of Chicago is found to proceed from the following sources:

	Per Cent.
Metallurgical furnaces and other manufacturing processes using fuel	64.26
High-pressure steam-power plants	19.34
Low-pressure steam-power plants and domestic heating	8.6
Railway locomotives	7.47

The locomotives, however, because their smoke is discharged near the ground, produce a somewhat larger proportion of the visible smoke, a little over 20% according to the figures of the commission.

It is evident from the above that if the steam locomotives were immediately done away with in Chicago, and other sources of air pollution allowed to continue unabated, the effect would hardly be noticeable by the general public.

Railway Electrification

In order to eliminate steam locomotives in Chicago it will be necessary to electrify the lines of 38 steam railway companies owning a total of 3,476 mi. of track, of which nearly half is main-line track. This mileage of electrified steam-railway line would be twice as great as the mileage of all the electrified steam lines in the entire United States and would be even greater, by about 15%, than the mileage of all the electrified lines in the world. The number of electric locomotives required would be about 2½ times the entire number now existing in the world.

The commission gave much attention to the selection of the best system for electrification, recognizing that if electrification were to be undertaken the system should be made uniform for all lines. The commission finally selected the overhead contact system using a single-phase current at 11,000 volts as on the whole the cheapest and most desirable. The commission recognized that there are objections to this system on account of danger to employees and also inductive interference with telephone and telegraph wires; but the difficulties are on the whole less than would be experienced were direct current used, either from a third rail or from an overhead wire.

The commission's estimate of the total cost of electrification showed a minimum of $178,127,000. A number of the railways entering Chicago, however, have taken this estimate and find that in order to operate their lines economically under the electrified plan it would be necessary to extend the electrification considerably farther than was assumed by the commission and also to make a large immediate outlay for track elevation and other improvements. These changes increased the estimate made by the commission by something over 50%. Applying this proportion to the commission's estimate as a whole, the final probable cost of electrification would be in round numbers $275,000,000.

The commission estimated that electrification would produce some gain in the railway earnings and some reduction in the operating expenses together sufficient to increase the net revenues of the railways by $2,336,000. Deducting this amount from the interest and depreciation charges on the cost of electrification, there is left an annual deficit of $14,600,000.

Railway Finances at Low Ebb

While some of the Chicago railways are in financial position to assume their share of the cost of electrification, most of the railway companies would find it absolutely impossible. In fact several companies are now in receivers' hands. The city could not share to any large extent in the expense of the work, since its margin of indebtedness under the state constitution would not permit it. If it were attempted to pay the cost of electrification by a tax upon the traffic passing through Chicago it would be a serious handicap to the business of the city in competition with other commercial centers. Moreover, were Chicago to require its steam railways to electrify their terminals, there is no doubt that numerous other cities might and would make similar demands.

It is especially to be noted that the commission's conclusions relate only to the electrification of the Chicago railways as a whole. It did not separately investigate the relative economy of electric operation for suburban service. There is a strong feeling in Chicago that some of its suburban steam lines, notably the Illinois Central, should be electrified not only for the relief from smoke and dust of the densely populated sections of the city through which the line runs, but because of the gain the company would make by reduced operating expenses and increased traffic. The commission held, however, that such investigations were the business of individual roads to make and that its duty was to deal with the problem presented by the proposed sweeping municipal legislation compelling electrification of the entire railway system of the city in order to abate the smoke nuisance.

Construction of Washington St. Arch Bridge at Indianapolis

SYNOPSIS—The plant and methods of construction for the foundations and superstructure of a new seven-span reinforced-concrete bridge across the White River are described in detail. Work is progressing from both ends with a very successful plant.

The new Washington St. Bridge over the White River at Indianapolis, Ind., is a reinforced-concrete arch structure with two spans of 106 ft., two of 112 ft., two of 117 ft. and a central span of 120 ft. The contract awarded by Marion County in 1914 was for a five-span bridge, but in July, 1915, the city gave a contract for two additional spans at the west end, in order to provide for the widening of the river in connection with the flood-protection work on the west bank. The present west end pier, therefore, is braced by temporary concrete buttresses to resist the arch thrust. The total length will be 844 ft.

The bridge washed out by the flood of 1913 had five plate-girder deck spans on concrete piers at right angles to the street and skew with the stream. The new bridge has the piers parallel with the stream and at about 60° with the street line. The piers are carried down 15 ft. below low water, except that the second pier from the east end, which is in the middle of the main channel, is carried down 25 ft. All the piers are on 25-ft. timber piles. The arrangement of the construction plant is shown on the accompanying drawing.

Foundation Work

The river bed is mainly gravel, but at the bridge site there is the débris of the old bridge piers, with large stones and masses of concrete which had to be removed in advance of the coffer-dam work. This clearing was done with a large stiff-leg derrick of timber construction and handling an orange-peel or clamshell bucket as required. The derrick travels on a track of 30-ft. gage and has a two-wheel (tandem) truck under each corner. At the middle of each side is another truck with a roller instead of wheels, this providing against deflection of the sills under load. The derrick clears the site of the pier, handles material, places filling outside the coffer-dam and does the dredging within the coffer-dams. A similar derrick is making the excavation for the two west spans. They are 15-ton machines with 60-ft. booms; but one has the boom spliced to a 75-ft. length. They were built by the American Hoist and Derrick Co.

Before commencing to drive the sheetpiling, the site for each pier is examined by a diver to see that all débris has been cleared away. This is a rather difficult task, owing to the muddy water.

The coffer-dams are about 30x115 ft., made of timber sheetpiles, 6x12 in., 25 ft. long. Each pile has two 2-in. yellow-pine splines nailed along one edge to form a dovetail groove and a single dovetail spline on the other edge. To secure the splines firmly, larger nails are used near the bottom, the holes being bored, so as not to split the wood in driving these large nails. The piles were driven with a Vulcan steam hammer slung from the derrick, a cast-iron cap being placed on the head of the pile. The entire set of piles was driven first to a depth of about 15 ft., when they began to drive hard. The inclosed space was then pumped out and the piles readily driven to full depth, the side pressure of the sand being reduced by lowering the head of water. The penetration is about 10 ft. below the base of the pier footing. At first this was only about 6 ft., but it proved insufficient and led to some blowouts. No other accidents occurred to the coffer-dams.

The wood sheetpiling was used because of its economy, easy driving and satisfactory closure. The piles can be pulled and used again, and when no longer available for sheeting are used for caps and falsework timbering. After the completion of the sheeting, dredged material was filled around the outside by the fixed derrick and by a floating derrick, both with clamshell buckets. The usual interior bracing was placed as the water was pumped out.

In driving the foundation piles, work was commenced at the middle of the pier and progressed outward. These piles were driven by a heavier Vulcan steam hammer. A water jet was used for both sheetpiles and foundation piles.

Arch Falsework and Forms

The arch falsework is of the special Luten design, in which piles carry caps transverse to the arch, and upon each line of caps are three rows of struts to the arch form, radiating in fan shape. Each strut is built up of two planks forming a column of T-section, the planks being fastened together only by wire ties wrapped around them. When the time comes to strike the centers, the wire ties are cut, when the struts resolve themselves into simple planks, which buckle under the load and are readily removed.

The ribs of the arch form are also of special and simple design. Each rib is made of 2x12-in. planks lapped and spiked over the posts (so that no cutting to shape is required), and upon them is nailed a separate 2-in. strip having its top cut to the curve of the arch. When the centering is removed the planks are ready for use again, and only the curved strips are waste. The forms are all of wood, shiplapped, and coated with paraffin on the face.

The spandrels do not rest upon the barrel of the arch but are placed against its side, forming the face of the arch and eliminating any horizontal joint. This arch ring is anchored to the arch proper. The top of the vertical joint is painted with an asphaltic waterproof coating. No outside bracing is required for the spandrel form, the form being secured by wire ties to anchors projecting from the side and back of the main arch. Another feature of the formwork is that the coping is built separately upon the spandrel. This permits the form to be set absolutely true to line, and the projection of the coping hides any slight bulges which may have occurred in the line of the spandrel.

Where the spandrel wall abuts against the pier it is made with a vertical V-groove in the end. In the form the open side of the groove is closed by a plank, forming

a triangular channel, which extends down to the pier and through the arch, so as to take care of drainage. This channel begins about 12 in. below the coping; thus there is no opportunity for dirt to fall into it.

Concreting 45 Hr. Continuously

Each pier is built as a monolith from 6 in. below low water to the bottom of the pier coping. The coping is poured next and then the skewback for the two arches. Each arch is poured complete, the 1,150 yd. of concrete being placed in about 45 hr., working 10-hr. shifts (two days and two nights). About the same speed was made at each end, using one large mixer with elevator tower and chutes at the west end and two smaller mixers with dump cars at the east end.

Drainage of the fill over the arch is provided for by pipes embedded in the piers and emerging below low-water line. They are galvanized-iron pipes placed in an inclined position so that there is no bend between the inlet and the outlet. This permits them to be cleaned out readily.

The concreting is being worked from both ends with two plants, but after the completion of the east end arch, with its abutment and pier, all the work will be done from the plant at the west end.

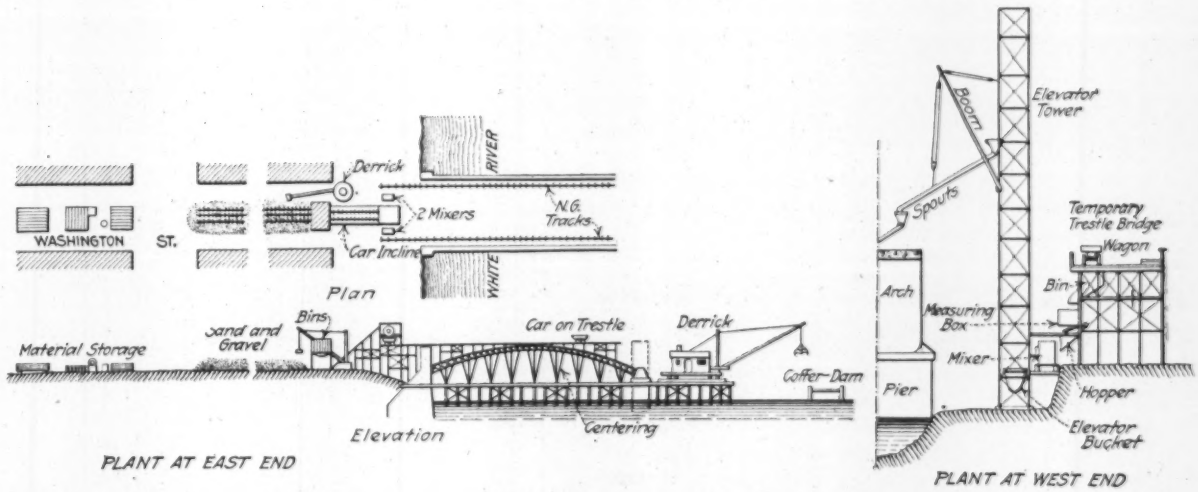
East-End Concreting Plant

As two blocks of Washington St. are closed to traffic, the center of the street is utilized for storing construction material. In the farther block are reinforcing rods, timber, etc. In the block next the bridge, sand and gravel are deposited by wagons on each side of the street-car space, and between these stock piles are three narrow-gage industrial tracks for steel dump cars. At the end of the street are three elevated bins over the tracks, and material is loaded into these by a stiffleg derrick operating a clamshell bucket. The material is dumped by the cars within reach of the derrick.

From the bins the material is loaded by gravity into the cars, which are hauled by cable up a two-track incline and dump into two ½-yd. Smith mixers, one on each side. The mixers in turn dump the concrete into similar cars on tracks just below them and running out over the arch.

At the west-end plant the mixer is placed on the river bank, below and at the side of the street. The storage bins are below the deck of the temporary trestle bridge. Dump wagons deliver sand and gravel over gratings in the street surface. The bins have gates over a measuring-box with a hinged bottom, which falls when unlatched (and is then closed by a counterweighted lever), dropping the contents through a steel hopper to the charging side of the ¾-yd. Smith mixer. The cement (from sacks) is dropped into the same hopper.

The concrete is discharged into a 1-yd. bucket in an elevator tower and dumped into the hopper of an Insley steel spouting system. The first spout is suspended from a 50-ft. boom on the tower, and the boom (with spout and hopper) is raised or lowered to the desired elevation by means of a hand crab. The tower is 124 ft. high and carries 300 ft. of spouting, which gives a horizontal reach of about 250 ft. This plant can place about 400 yd. per day in one 10-hr. shift, and has made a record of 422 yd. placed in 11 hr.



ARRANGEMENT OF CONSTRUCTION PLANT AT THE WASHINGTON ST. BRIDGE OVER THE WHITE RIVER AT INDIANAPOLIS, IND., SHOWING CONCRETING PLANTS AT BOTH ENDS
Not drawn to scale

Concrete and Surface Finish

The concrete is 1:2:4 mix, made with river sand and gravel, the maximum size of aggregate being 1½ in. This material is dredged from the river by a dragline cableway with a 1-yd. Shearer-Mayer bucket. The gravel is washed and screened and delivered to bins, from which it is loaded by gravity into the dump wagons. This washing plant has a capacity of about 125 cu.yd. of gravel per day. The reinforcement is of deformed bars; but only a relatively small proportion of steel is required.

The face treatment of the bridge is simple and effective. Large panels are formed on the spandrels and

The construction plant includes also a floating derrick (for dredging, etc.) and a hand-power bending machine for the steel rods. For the timber work there is a carpenter shop having a ripsaw, cutoff saw and grinder. Another shed is used for molding the balustrades. All the derricks, concreting plants, etc., are operated by steam, except that one mixer at each end has an electric motor.

upper parts of the piers, but these are in the same plane with the rest of the work, so that the only form construction required is the nailing of V-strips for grooves outlining the panels. The panels are bush-hammered by hand and the remainder of the surface is rubbed with carborundum blocks while wetted with a thin cement grout applied by whitewash brushes.

The parapet has balustrades which are molded in a shed near the work, using a Pettyjohn mold. Each has a rod projecting from the bottom and engaging a groove in the coping, this groove being afterward filled with mortar. Upon the balustrades rests a cap, but this is not anchored to them and is free to move longitudinally with contraction and expansion movements, without disturbing the balustrade.

ENGINEERS AND CONTRACTORS

The bridge was designed by Daniel B. Luten, consulting engineer, of Indianapolis. He also designed and patented several of the construction features, including the T-beam arch struts, the arch reinforcement and the spandrel arrangement. The contractor for the entire work is the National Concrete Co., of Indianapolis. The work is under the direction of Charles E. Cheney, County Engineer, and B. J. T. Jeup, City Engineer. The total cost will be nearly $500,000.

Combined Fire and Load Tests of Building Columns

Testing the strength of building columns under conflagration conditions has hitherto been impossible because there has not been a machine built in which fire and load could be applied at the same time. Realizing the necessity of information on this subject, a joint body, formed of the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the United States Bureau of Standards, has had designed and built a testing machine in which full-sized building columns can be tested to destruction under end load and at the same time subjected to temperatures equaling those of a general conflagration.

This machine has been set up in the Underwriters' Laboratory in Chicago, and a series of fire tests of building columns has been outlined. A prospectus of the series has just been issued. Herewith is given an abstract of this prospectus, together with a detail drawing of the machine. Engineers and insurance experts interested in the subject have been asked for suggestions and criticisms of the prospectus and it is expected that as soon as these criticisms have been digested the tests will be initiated. Any information regarding the work not included in this abstract can be obtained by writing to the Underwriters' Laboratory, 207 East Ohio St., Chicago, Ill.

GENERAL PLAN OF INVESTIGATION

The object of this investigation is to ascertain the ultimate fire resistance of centrally loaded columns used in the interior of buildings, under conditions approximating those of service; to ascertain the fire-retardant value of the column protection provided by the various materials and methods commonly employed in protecting columns against fire; to obtain full and accurate data that will serve as a basis for the classification of column protection for various classes of buildings, and to furnish data for guidance in the determination of proper test conditions for heavier columns, and special tests to ascertain the effect of the application of fire streams to columns while in a highly heated condition.

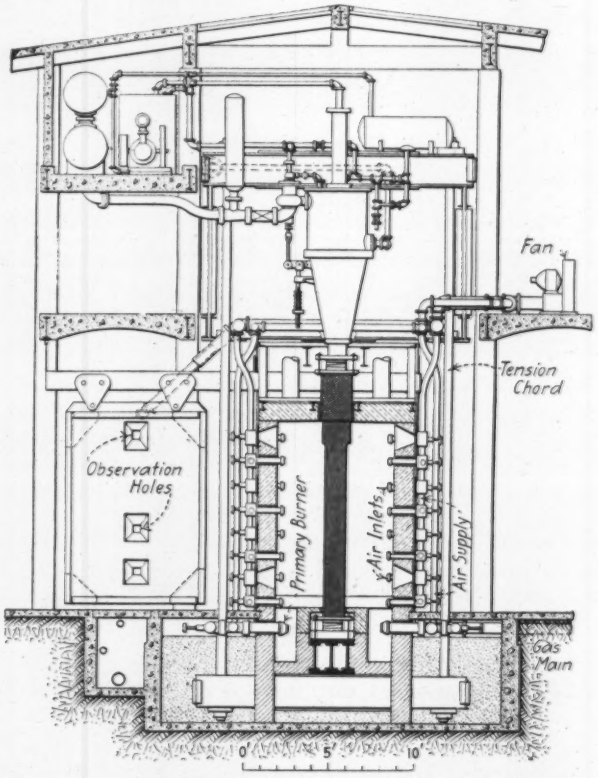
Test columns consisting of the types of columns commonly employed in building construction, specially designed for the test apparatus and for safe rated loads of approximately 500 tons, have been secured.

It is proposed to protect these columns, except one of each type, by various methods commonly employed in fireproofing building columns, and to allow them to season under proper conditions for a period of six months before they are tested.

It is proposed to make supplementary standard tests to ascertain the quality of the materials employed in the construction of the test columns.

It is proposed to subject each of the columns to its safe rated load and to temperatures increasing at a predetermined rate until failure, or until the column has withstood the temperature conditions in excess of 8 hr.

It is proposed to measure and record at regular intervals during the test the temperatures in the furnace and at various



SECTION THROUGH MACHINE FOR TESTING STRENGTH AND FIRE RESISTANCE

points on the surface of the structural portion of the column, the deformation and deflection of the column near the middle, and to record the results of observations relative to the effects of fire on the column and on the column protection.

It is proposed to make careful examinations after the test and a record of the condition of the column and column protection.

It is proposed to make photographic records of the column before and after the test and after the column protection has been removed.

It is proposed to make a supplementary series of tests upon additional test columns to determine the effect of the application of fire streams to columns while in a highly heated condition.

DESCRIPTION OF PROPOSED TEST COLUMNS

The types of columns to be tested include rolled-steel sections, built-up steel sections, round cast-iron sections, steel pipe filled with concrete, and vertically reinforced and hooped concrete columns, to which it is proposed to add several wooden columns. At least one of each of the sections is to be unprotected; others are to be partially protected by concrete, and others completely protected by various thicknesses of concrete, clay tile, gypsum blocks and plaster on metal lath, in accordance with the methods commonly employed in practice.

The test columns, with the exceptions noted, are 15 ft. 8 in. long between bearings. The upper 3 ft. is made of extra-heavy section to serve as a medium for the free transmission of the load from the ram through the roof of the furnace to the heated portion of the column. The extra-heavy section is assumed to establish an effective length of 12 ft. 8 in. as a basis for calculating the safe rated load of the column. The pipe columns and two of the cast-iron columns are approximately 12 ft. 6 in. in length and provided with square end bearings.

The test columns are provided with two brackets near the top to simulate the details used for beam and girder supports and conditions affecting the application of fireproofing at these points.

The materials used in the construction of the test columns and protective coverings are to be obtained from various sources and from various sections of the country, and are to be selected with a view of obtaining those representative of their respective classes.

Columns partly protected by filling the reëntrant portions with concrete are introduced as a type made necessary where space limitations prevent the use of full protection. Besides giving information on the merits of this type of protection as compared with unprotected steel, cast-iron and wooden columns, it is also thought that they will give further data on the influence of type of steel section on fire resistance. The concrete aggregates are the same as those used in the tests of the fully protected columns of the corresponding sections.

APPARATUS TO BE USED

The apparatus to be used in the tests is specially designed for the purpose, and consists of a carriage and traveling crane for handling the test samples, a furnace in which the columns are subjected to fire, a hydraulic ram and restraining frame by means of which the loads are applied to the columns, the apparatus for measuring the temperatures of the furnace and the test samples, the apparatus for measuring the deformation of the test samples and a flexible nozzle by means of which streams of water are supplied in the fire-stream tests.

DETAILS OF TEST FURNACE

The test furnace, which is shown herewith, consists of a combustion chamber 7 ft. square and 12 ft. high, exclusive of two shallow pits to receive falling material and carry off the water during the fire-stream tests. The sides are formed by two stationary brick walls and two movable brick walls in steel panels suspended from overhead beams by trolleys. The top of the furnace consists of heavy fireclay blocks supported by a steel frame, and is partly removable to permit the installation of the test columns. The bottom is formed by the fireproofing on the steel bearing plate and restraining frame of the loading apparatus. The products of combustion are carried off through four 13-in. flues extending from the furnace through the roof of the building. Each side of the furnace is provided with mica-glazed observation holes, so arranged near the top, middle and bottom that all parts of the test column can be observed. Observation galleries outside the furnace afford access to the upper observation holes.

The furnace is heated by means of eight 6-in. specially designed blast burners, extending in at the corners and the middle of the sides and arranged so that they discharge horizontally toward the center of the combustion chamber at the bottom. The burners are supplied with gas through mixing tubes connected to circulating mains located in a shallow pit under the floor outside of the furnace. Each burner is provided with valves for regulating the gas and air.

The additional air necessary to complete combustion and distribute the fire is supplied by secondary air inlets extending through each side of the furnace at regular intervals toward the top, each inlet being provided with a regulating valve.

Gas is supplied to the furnace through a 6-in. pipe connected to the street main. Air is supplied to the burners and to the secondary inlets by means of an electrically driven blower capable of maintaining uniform air pressure.

TEMPERATURE AND DEFORMATION MEASUREMENTS

The temperatures within the furnace are indicated by means of thermocouples inserted through the walls near the top, middle and bottom. The temperatures at the surface of the structural portion of the test column are indicated by thermocouples placed at the same levels as the furnace couples.

The deformation and deflection of the column during test is to be taken by measuring the movements of protected wires attached near the middle of the column. One end of each wire is attached to the column and the other is weighted and passed over an idler at a point outside of the furnace and as far from the column as the room conditions permit. The movement is measured at an intermediate point on the wires, and the true movement at the point of attachment to the columns calculated from the established ratio of distances.

LOADING APPARATUS

The apparatus to be employed in applying the loads to the columns during the fire and fire-and-water tests consists essentially of a hydro-pneumatic ram, the pumps and tanks supplying the pressure, restraining frames and pressure-indicating, controlling and recording apparatus.

The ram has a rated capacity of approximately 256 tons and is bolted to the under side of the heavy steel beams forming the top of the restraining frame in such a manner that it will engage the top plate of the test column when in position. The column transfers the compression to the beams, constituting the bottom of the frame, which complete the action by transferring the stresses back to the top through steel tension chords forming the sides of the frame. The framing supporting the restraining frame at the top is also designed to aid in supporting laterally the lower end of the ram and resist any racking set up by eccentricity of the loads when the test columns are deformed in the tests.

The ram is designed to automatically maintain the load on the test column and develop characteristic deformation at the point of failure. In case of sudden complete failure, the loss of the load is judged to be immaterial, inasmuch as the load at which the column fails is known. In case of gradual failure, such as can be expected in the majority of cases, the ram is capable of maintaining the load until characteristic deformation of the column is secured. In case of sudden but incomplete failure of the test column, some loss in the load may take place, but this will be automatically recorded and is not considered important, inasmuch as the full load throughout the complete period of deformation would probably only increase the rate of deformation, the characteristics of which have already been observed.

The ram is connected by a 6-in. pipe to steel tanks in which the operating water and air pressures are stored, and is provided with a controlling valve that can be set to automatically shut off the pressure after any predetermined downward movement of the plunger less than 24 in. has taken place. It is also designed to absorb the impacts and withstand the pressures in case of the failure of the automatic controlling valve. A separate lifting cylinder and pressure tank by means of which the plunger of the ram can be independently raised and lowered is attached to the ram. Water and air pressures as high as 500 lb. per sq.in. are supplied by an electrically driven pump and compressor. The pumps and tanks are equipped with the necessary pressure gages and the ram with pressure-recording apparatus. The connections are provided with the valves necessary for the manual control of the loading apparatus.

Adjustable bearings are provided at the top and bottom of the test columns to insure the central application of the loads.

METHOD OF CONDUCTING TESTS

After being allowed to season for six months, the column is to be placed in the furnace and the top and bottom bearings adjusted for even distribution of load. The connections are then made with the instruments for measuring heat and deformation and the furnace closed and readings on all instruments taken. After applying the safe rated load, readings are again taken for deformation and deflection.

The gas is then lighted and gas and air gradually turned on to establish the predetermined temperature rise in the furnace. This is proposed to be made uniform for all tests and to be such that a temperature of approximately 1,500° F. is attained in 30 min., 1,700° F. in 1 hr., and 2,000° F. in 4 hr., beyond this point the temperatures being very slowly increased to a maximum of 2,300° F.

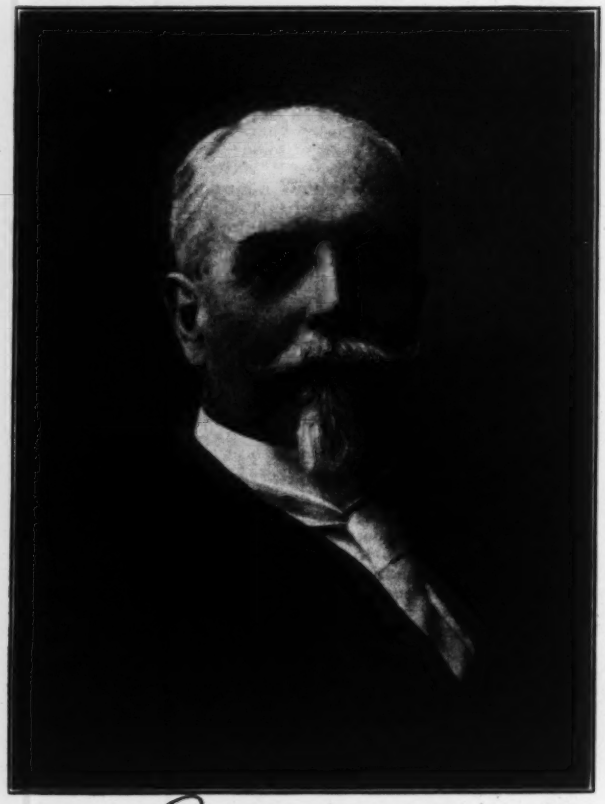
Readings on gages for load, on column and furnace thermocouples for temperature and on deformation and deflection instruments are to be taken in regular order at five-minute intervals up to a point near failure, the load being maintained as nearly constant as possible during the whole test. Observations of the visible effects of the fire on the column and its protection are to be made at regular intervals during the progress of the test.

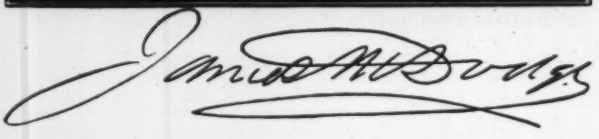
After failure, the furnace doors are to be opened and the column allowed to cool. Photographs and notes are to be made showing the general condition of the column after test. The covering is to be then removed, and constituent materials examined for deterioration due to fire.

Street Railway Given to City.—It is reported that the street-railway system in San Angelo, Tex., has been offered to the municipality as a Christmas present. The authorities are undecided whether to accept it or not, as it is unprofitable. The line is 5 mi. long and has six motor cars, one work car and a power station; the value is placed at $100,000.

James Mapes Dodge

James M. Dodge, Chairman of the Board of Directors of the Link-Belt Co., Philadelphia, Penn., died at his residence in Germantown, Philadelphia, on Saturday, Dec. 4, aged 63 years. Mr. Dodge was a native of New Jersey. His maternal grandfather, James J. Mapes, was an eminent chemist and scientist. His mother, Mary Mapes Dodge, was widely known through her editorship for many years of the juvenile magazine, *St. Nicholas*. Mr. Dodge was for three years a student at





Cornell University; then he spent a year at Rutgers College, New Jersey, where he took a special course in chemistry. His early engineering work was in the field of shipbuilding. Starting in as an ordinary workman at the famous old shipyards of John Roach, at Chester, Penn., he became at the end of three years superintendent of erection.

In Chicago about 1880 Mr. Dodge became acquainted with William D. Ewart about the time that the latter had invented and patented a new type of sprocket-chain transmission, using separable links. Mr. Dodge joined Ewart and his associates in the commercial development of this invention, and it determined his future business career.

At the time of the Ewart invention the sprocket wheel and chain, although an old device for the transmission of motion, was hardly used in machine construction or engineering. Mr. Dodge's inventive genius found full scope in the new industry in the development of various devices intended to utilize the chain transmission. The application of chain transmission to large power installations led to the formation, in 1888, of the Link-Belt Engineering Co., where under Mr. Dodge's direction a strong engineering and scientific organization was built up.

In 1889 Mr. Dodge brought out his now well-known system of anthracite coal storage, using the Link-Belt conveyor to deliver the coal in great conical piles. A separate organization, the Dodge Coal Storage Co., was formed to exploit this invention. The extent of Mr. Dodge's original work may be judged by the fact that he took out over a hundred United States patents on his inventions.

Mr. Dodge was among the best-known members of the American Society of Mechanical Engineers. He joined the society in 1884, only four years after its organization. He was elected one of the managers of the society in 1891, was a vice-president in 1902 and was elected to the presidency in 1903. Mr. Dodge also took great interest in the Engineers Club of Philadelphia and in the Franklin Institute and was vice-president of the latter organization.

A Year of Activated Sludge at Milwaukee, Wis.*

By George W. Fuller†

During the past year, and in fact for many years, there has been in the field of sewage disposal no step in advance so notable in many ways as that associated with the use of activated sludge.

In point of correctness as to theory this process seems to rest on a sound basis. What its shortcomings may be from an operating standpoint in actual practice, and what its operating costs and indeed its total costs may involve for plants of different sizes and for widely varying local conditions, are all propositions upon which further data are needed before arriving at final conclusions.

The activated-sludge process has many points of similarity to the filtration of sewage in filter beds, in that it offers an opportunity for the sewage to come in contact with surfaces suitably prepared as to biological growths, promoting nitrification and other bio-chemical changes. In a sense, it is a reversal of the filtration process in that the purifying medium is moved up and down through a tank of sewage, rather than the liquid moved through a bed of stone, each particle of which is surrounded with films containing bacterial growths and the products of bacterial growths, all of suitable physical and biological character.

About two weeks ago I visited the Milwaukee sewage-testing station, noted the activated-sludge investigations there and discussed them with Messrs. Hatton and Copeland and other members of the technical staff. The following tentative deductions regarding this process may be drawn at this time, which marks a transitional stage between the strictly experimental work at Milwaukee and numerous places elsewhere, and the actual operation at Milwaukee of a plant on a working scale:

1. Having secured an adequate quantity of properly activated sludge, it is necessary in its utilization to ap-

*Slightly condensed from a paper read before the New Jersey Sanitary Association, Lakewood, N. J., Dec. 3, 1915.

†Consulting Engineer, 170 Broadway, New York City.

ply a certain minimum quantity of air. This quantity must be at least sufficient to effect a thorough commingling of the activated sludge with the sewage to be treated by it.

2. When the sludge is properly activated and adequately commingled with the sewage to be treated, a period of two hours or less is sufficient to bring about substantially complete clarification through the attachment of the fine colloidal particles to the more or less gelatinous surfaces of the activated sludge. This is the only process besides intermittent sand filtration that seems practicably capable of thorough clarification.

Bacterial Removal

3. With the removal of colloidal matters there are also eliminated the great majority of the bacteria, and with a period of aëration of from 2 to 3 hr. the removal of bacteria may be expected to approach 96 to 99%, or substantially as high an efficiency as may be expected with sand filters.

4. It appears that the Milwaukee sewage may be well clarified and well freed of bacteria, after sedimentation, but without the establishment of nitrification. Such an effluent will not remain nonputrescible for more than say four or five days.

5. Still further improvement in the quality of the effluent of the activated-sludge method is brought about by the nitrification and other oxidation processes characteristic of activated sludge, and more or less resembling the action effected by the ripened films surrounding the solid medium of sewage filters.

6. Nitrification to the point of securing complete stability may be effected within certain limits by applying air in greater quantities per volume of sewage treated or by a prolongation of the time during which the activated sludge is brought in contact with the sewage to be treated and with the rate of application of air sufficient to bring about a commingling of the activated sludge throughout the liquid to be treated. At Milwaukee it is stated that nitrification increases in a roughly proportional way to the duration and intensity of the aëration, although there are apparently some exceptions to these general rules. Incidentally, mention may be made of the fact that the application of this process may be adjusted to different degrees of stability of effluent, of which there will doubtless be variations in individual viewpoints, just as is the case in deciding upon the best depth of sprinkling filters.

7. The duration and intensity of aëration ought to be adjusted to the sewage flow for those portions of the day when the volume and strength of the sewage are greatest. Then for those portions of the day when the sewage is weaker and less in volume the result will be a higher degree of nitrification than that which would be decided upon as suitable for the maximum load as to strength and volume.

8. The indications are that the beneficial effect of activated sludge may be lost in varying degrees and in a variety of ways, of which mention may be made of the following:

A. Excessive aëration may break up the particles of activated sludge so as to reduce materially the adequacy of the spongy gelatinous surface for removing colloids. Perhaps this may be made clearer by saying that the inner surfaces of disintegrated portions of activated sludge may themselves under some circumstances utilize a portion of the gelatinous activated material, and thus reduce the quantity available for the withdrawal of colloids of the sewage to be treated.

B. Fine mineral suspended matter, say from street washings and present in the effluent of a grit chamber, may saturate the gelatinous surfaces of the activated sludge so as to preclude normal action by the latter upon the colloids of the sewage.

C. The activation of the sludge may be carried to a point where it is "burnt up," or where the material within or underneath the gelatinous surfaces of the sludge particles no longer stimulates a continuous bacterial growth along normal lines.

D. Inadequate or insufficient aëration might cause a temporary breakdown of the process, the correction of which would require more or less re-activation of the sludge at hand. This feature in practice will need attention, as complete activation of the sludge seems to require a month or more of frequent if not continuous aëration.

9. It is believed at Milwaukee that the activated-sludge process will prove markedly successful in removing with great promptness the odoriferous compounds found in sewage, and if this should prove generally true it is believed that the marked practical benefit will justify costs in excess of methods of treatment not capable of freedom from odor.

10. Data are not yet available to show what may be expected during the winter months as to diminished performance of the process due to low temperature of the sewage, other things being equal. A somewhat more intense application of air or a longer period of treatment or a somewhat lessened degree of stability of the effluent in various combinations may make the problem appear more simple than is thought to be the case by some observers at present. Keen interest will be felt in the outcome of the Milwaukee experiences during the coming winter with its new plant capable of treating 1,600,000 gal. of sewage daily.

Drying of the Sludge

11. The surplus sludge removed from the sedimentation tanks into which the sewage passes after it leaves the aërating tank apparently will dry quickly, and it is free of offensive odors as removed and dried. This does not necessarily mean that it will not ultimately decompose and produce foul odors if allowed to accumulate in bulk. Preparation of this sludge for use as fertilizer seems to be a proposition necessitating considerable careful study, and it yet remains to be seen whether the sludge can be sold for enough money to pay for its own treatment. The practical outcome of sludge disposal in this process must depend upon data to be secured in the future.

12. Although it is not the purpose of this discussion to go into the question of costs of the complete process based on present data, it may perhaps not be amiss to point out, in a process where the cost of power and attendance will vary much under local conditions and depend upon the size of the plant, that the method may work out admirably for a plant of 50,000,000-gal. capacity, and even for one of 5,000,000-gal., whereas it may prove markedly expensive for a plant of say 500,000-gal. daily capacity.

News of the Engineering World

Activated-Sludge Treatment for Packing-House Wastes

The treatment of stockyards' sewage and industrial wastes before discharge into the Chicago River is being forced upon the attention of the meat-packing firms, and has been under consideration by these firms and the Sanitary District of Chicago for some time. The District made a report on the subject about a year ago, but since then the activated-sludge process has come to the front. As this process promises a byproduct of considerable fertilizing value and is otherwise promising, several of the large packers began to conduct a series of experiments with it.

After successful experiments with small tanks, Armour & Co. have now an experimental activated-sludge plant with a tank of 20,000-gal. capacity, which is worked on the continuous-process method. This was put in service early in November, 1915, and has given excellent results. Morris & Co. and Swift & Co. have plants of the same general character, and the latter is said to intend building a 500,000-gal. plant. Sulzberger & Sons Co. is reported as experimenting with both the activated-sludge and electrolytic processes.

These experiments are independent of but in relation with the investigations which have been carried on for some time by the Sanitary District of Chicago regarding the activated-sludge process for treatment of trade-waste products at the stockyards. The District recently appropriated $10,000 for further experiments, and is building a plant to handle 150,000 gal. per day. A committee of five members appointed by the packers represents them in discussions of the problem with the Sanitary District authorities.

Supreme Court Decision on Asphalt-Paving Guarantee

Certain streets in St. Paul, Minn., were paved with sheet asphalt by the Barber Asphalt Paving Co. under a 10-yr. guarantee or maintenance clause. During six years of the maintenance period the asphalt company made repairs at the request of the city. It was then discovered that the defects were caused chiefly by leakage from gas mains, poor construction of the street-railway tracks and other causes beyond the power of the contractor to prevent. On subsequent work of a similar nature the contractor demanded payment for repairs, and on refusal by the city brought suit.

The maintenance clauses in the contract were indefinite, and the contractor contended that they should be interpreted to cover only repairs made necessary by defective material or poor workmanship, while the city contended the maintenance clauses were so broad that they covered such repairs as those under question. The United States Circuit Court upheld the city's contention, and stated:

> If the gas company was negligent in permitting gas to escape, which caused injury to the pavement, it might be liable to the plaintiff . . . But even if there had been some ambiguity in the language used in the contracts, the construction placed upon them by both parties during all that time, from 1901 until the institution of this suit in November, 1912, that these repairs had to be made by the paving company at its own expense, would effectually remove the ambiguity. The law is well settled that, if there is any doubt or ambiguity in a contract arising from the words employed, it is effectually removed by the practical construction continuously put upon it by the parties for so long a period as was done in this case.

The case was taken to the United States Circuit Court of Appeals, where the decision was upheld, and subsequently a petition for a writ of certiorari was made by the plaintiff to the United States Supreme Court, which was refused.

The decision establishes that if a contractor makes paving repairs for any considerable time and afterward claims that these are not covered by his maintenance obligation, the courts will construe his having made repairs without objection as evidence that this is his own interpretation of the maintenance clauses, and that they are accordingly binding. On this point only is the decision of importance, for it opens the way to making the gas company responsible for the repairs even though the city is not.

Lackawanna R.R. to Have New Coal Pier at Buffalo

The Delaware, Lackawanna & Western R.R. has just started at North Pier in Buffalo, N. Y., the construction of a new coal pier and dumper with a capacity of 300 cars per day.

At the present time there is in use at this point an ordinary coal trestle having a capacity of about 5,000 tons. The trestle has been in use for a number of years and has about reached a point where it requires rebuilding. In addition to this, the United States Government objected to the fact that boats had to lie in the channel of the Buffalo River while loading. After considerable discussion between the officers of the railroad company and the United States War Department, the railroad company was finally required to excavate a slip entirely on its own property and parallel to the face of the present dock. In order to do this, it became necessary to cut back the entire frontage for a width of 90 ft., which gives room to put in a slip 66 ft. wide and to build an outer protection pier 24 ft. wide.

It is intended to put in a timber crib below the water line and a concrete retaining wall above the water line, along the inner side of the proposed slip. It is also intended to build the protection pier entirely of reinforced concrete, using the floating reinforced-concrete caisson method similar to that devised for the Lake Ontario entrance to the Welland Ship Canal, described in *Engineering News*, June 10, 1915. A marine railway will

be built at some point adjacent to the site of the proposed protection pier, on which to build necessary caissons. These caissons will be in sections of about 100 ft. in length, are to be fitted with pipes and valves so that they can be filled with water and sunk, and they will have movable wooden floors and necessary cross walls. The ends are to have keys for keeping adjacent sections in line with each other. After the boxes are sunk in place they will be filled with stone or other material. It is intended to dredge the channel out to a depth of 23 ft. below mean water, and the caissons will be made 23 ft. in width.

For handling the coal it is intended to put in a car dumper having a capacity of 75 tons. The matter of handling the screenings and the handling of coal from box-cars have not as yet been fully decided. There is handled during the season of navigation at this point from 1,600,000 to 1,800,000 tons of coal.

Dredging is already under way and the contract for the car dumper has been let to the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, and it is the understanding that the car dumper is to be in operation by the first of June, 1916. George J. Ray is chief engineer of the railroad company.

Commission of Scientists to Study Panama Slides

A commission of scientists has been selected by the President to visit the Panama Canal and to investigate and report on the slide situation. The men were nominated by the National Academy of Sciences at the request of President Wilson. It is reported that they will sail for Panama on Dec. 11 to be gone about four weeks. The personnel of the commission is as follows:

C. R. Van Hise, President of University of Wisconsin, Chairman.
George F. Becker, U. S. Geological Survey.
Arthur L. Day, Geophysical Laboratory, Carnegie Institute.
J. F. Hayford, Dean, College of Engineering, Northwestern University.
Harry Fielding Reid, Professor, Johns Hopkins University.
Charles D. Walcott, President, Smithsonian Institution.
J. C. Branner, President, Leland Stanford, Jr., University.
Arthur P. Davis, Chief Engineer, United States Reclamation Service.
H. L. Abbot, Brigadier General, U. S. A., retired.
R. C. Carpenter, Professor, Cornell University.
John R. Freeman, Consulting Engineer.

Extensive Railway Improvements at Elizabeth, N. J., are projected by the Pennsylvania R.R. and the Central R.R. of New Jersey. Plans have been prepared by R. W. Creuzbaur Consulting Engineer for the City of Elizabeth.

The Demolition of the Panama-Pacific Exposition Buildings was begun Dec. 6. Nothing east of the Fine Arts Palace will be retained. It is probable that the yacht harbor and possible that the Fine Arts Building may be kept. A marine boulevard may be constructed.

The Contract for Constructing the Hetch Hetchy R.R. for use in developing the Hetch Hetchy water-supply by San Francisco, Calif., was awarded on Dec. 6 to F. Rolandi, 550 Montgomery St., San Francisco, for $1,543,081. This was the lowest of five bids, the details of which are given in the construction news pages of this issue. A description of the railroad project was printed in "Engineering News" of Nov. 11, 1915, p. 925.

The Chicago Subway Project has made another step, the City Council having passed an ordinance for the appointment of a committee of three engineers to investigate and report upon the matter. One member is to be a Chicago man, and the others are to be men familiar with conditions at New York, Boston and Philadelphia.

A New Reinforced-Concrete Stadium to seat 5,000 persons will be started soon at the University of Wisconsin. It will be completed in time for the games of next fall. An appropriation of $20,000 has been made by the State Legislature for the erection of the first section of the new stadium. This section will be semicircular in form and will contain 40 rows of seats. It will be built in such a way that it can be extended around the two sides and perhaps in the future be made into a stand inclosing a field.

The St. Paul Union Station Plan as submitted by the United railways to the city and Federal government ("Engineering News," Mar. 11, 1915, p. 488) has been withdrawn in its entirety, following the rejection of the harbor details of the scheme by the Chief of Engineers, U. S. A. The plans were drawn under an Act of Congress providing for the bettering of river navigation and river transportation facilities at St. Paul, the harbor line and river being moved a maximum of 400 ft. for 6,000 lin.ft. The United States engineers declined to appove the plans on grounds which to the railroad companies seemed fundamental, and new plans will now be drawn which will not require the approval of the Federal government. This will mean the selection of a new site and the purchase of grounds.

The Proposed New Jersey Ship Canal, which is to run between the Delaware River and Raritan Bay, is to be surveyed during the coming winter under authority from the State of New Jersey. The surveys will be in charge of W. F. K. Griffith under the direction of B. F. Cresson, Jr., Chief Engineer of the Department of Commerce and Navigation of the state. The route for this canal has already been surveyed from Bordentown to Jamesburg, so that the work remaining is for the section between Jamesburg and Morgan, the latter being the terminal point in Raritan Bay. This route is one investigated some years ago by the U. S. Army engineers and is included in the Inland Waterways scheme now being advocated as a measure of military preparedness.

Blowout Delays East River Tunnel Work—A blowout in the south tunnel, west end, of the pair of rapid-transit tunnels which the Flinn-O'Rourke Co. is driving from Old Slip, New York, under the East River, filled the tunnel at the shield with water and stopped work until clay cover was placed on the river bottom to seal the demoralized ground. The accident happened Nov. 30. The south shield was partly under the riverfront bulkhead wall, which here is a concrete-block wall on bagged concrete on rock. The tunnel crown is 4 to 5 ft. above rock, which is at El. 28. Just outside the bulkhead, in the slip, the earth cover over the shield is about 14 ft. Air leaking along the shield from the tail, since the cutting-edge began going through the wall foundation, rose up in the slip and loosened the ground. When the cutting-edge was about 8 ft. out from the wall, the rear half of the shield being under the wall, the sheeted earth face at the top of the shield gave way just after a blast in the rock portion of the face below. A leak to the river bottom developed, which brought in water as the air pressure dropped from 14 lb. to 11 lb. The inflow was slow, but attempts to plug the leak with bagged sawdust did not succeed, and in 20 min. the shield was submerged, the upper part of the tunnel slope still holding 11 lb. air.

PERSONALS

Mr. William B. Bartholomew has been elected Director of Highways and Mr. Thomas J. Roth, Director of Public Property, of the City of Allentown, Penn.

Mr. Oliver S. Kelsey, Lock Haven, Penn., has been appointed by Gov. M. G. Brumbaugh a member of the Pennsylvania Water Supply Commission to succeed B. F. Focht, congressman-elect, resigned.

Mr. George R. Henderson, M. Am. Soc. M. E., has severed his connection with the Baldwin Locomotive Works and opened

an office for the practice of consulting engineering at 1321 Walnut St., Philadelphia, Penn.

Mr. Charles Boettcher, of Denver, Colo., has been elected President of the Denver & Salt Lake R.R. He succeeds Mr. Newman Erb, of New York, who has been President since the reorganization of the road two years ago.

Mr. R. P. Black, M. Am. Soc. C. E., formerly Engineer of Maintenance of Way of the Kanawha & Michigan Ry., at Charleston, W. Va., has opened an office in Atlanta, Ga., as a construction engineer. Mr. Blank is also President and Treasurer of the Spencer Turbine Cleaning Co., of Atlanta.

Mr. W. B. Saunders, M. Am. Soc. C. E., Consulting Engineer, of Minneapolis, Minn., and recently with the Great Falls Power Co., Great Falls, Mont., has been appointed Engineer of the Montana State Office of Railroads and Public Service Commissioners, with headquarters at Helena, Mont.

Mayor-elect Harry L. Davis, of Cleveland, Ohio, has appointed Mr. Fielder Sanders, former county judge, Director of Traction Service; Mr. Thomas Farrell, formerly Secretary of of State Federation of Labor, has been appointed Director of Public Utilities, and Mr. Alex Bernstein, for six years a member of the City Council, has been appointed Director of Service.

Mr. Edward N. Lake, Fellow, Am. Inst. E. E., formerly in charge of the Chicago office of the Stone & Webster Engineering Corporation, of Boston, has become a partner in the firm of Krehbiel & Co., Engineers and Constructors, with offices in the Marquette Bldg., Chicago. The business will be continued under the present firm name. Mr. Lake will be Treasurer and Manager, and Mr. Krehbiel will continue as President.

Mr. W. Thomas Wooley, City Engineer of Syracuse, N. Y., has accepted a similar appointment with the City of Schenectady, N. Y., effective Jan. 1. Previous to his present position, Mr. Wooley was City Engineer and Architect of Schenectady, and prior to that Engineer of the Public Improvement Commission at Hoosick Falls, N. Y., and City Engineer of Auburn, N. Y. He is a graduate in civil engineering of Rensselaer Polytechnic Institute.

Mr. Charles W. Okey, Assoc. M. Am. Soc. C. E., Engineer, Division of Drainage Investigations of the Office of Experiment Stations, U. S. Department of Agriculture, has assumed charge of the consolidated field offices at New Orleans for the states of Texas, Arkansas, Louisiana, Mississippi, Florida and part of Alabama. Since July 1, 1915, the drainage work has been under the Office of Public Roads and Rural Engineering, Department of Agriculture; the various field offices have been consolidated and established at Berkeley, Calif., Denver, Colo., and New Orleans, La., in addition to the central office at Washington. Mr. Okey will continue to give special attention to land drainage by pumps in all sections of the country.

The Pressed Steel Car Co., Pittsburgh, Penn., announces the following changes, to take effect immediately: Messrs. N. S. Reeder, M. Am. Soc. M. E., has been elected Vice-President, with headquarters at New York; J. B. Rider elected Vice-President, with headquarters at Pittsburgh. He will continue to perform the duties of General Manager in Charge of Operations; J. F. MacEnulty, formerly General Sales Manager, elected Second Vice-President, with headquarters at New York; C. E. Postlethwaite, formerly Manager of Sales, Central District, Pittsburgh, appointed General Sales Manager of the Pressed Steel Car Co. and the Western Steel Car and Foundry Co., with headquarters at New York; H. P. Hoffstot appointed Assistant Sales Manager, Central District, with headquarters at Pittsburgh.

Mr. C. J. Larsen, Assoc. Am. Inst. E. E., Electrical Engineer, with headquarters at 227 Federal Square, Harrisburg, Penn., has been appointed to make a survey of the facilities of the independent telephone companies of eastern Pennsylvania with a view to bringing about a standardization of operating methods, improvement in central-office equipments, inspection of toll lines and adoption of long-distance routes between connecting companies. This work is being undertaken under the direction of the service committee of the Independent Telephone Companies of Pennsylvania, Maryland and Virginia, which includes Messrs. E. M. Prisk, Consolidated Telephone Co., Hazleton, Penn.; H. M. Tracy, Cumberland Valley Telephone Co., Harrisburg, Penn.; A. J. Ulrich, Keystone Telephone Co., Philadelphia, Penn.

Mr. Edward E. McCall, Chairman of the Public Service Commission, First District, New York, has been removed by Governor Whitman on the ground that he has violated the law by holding stock in a public-utility corporation. Mr. McCall is charged with holding 387 shares of stock in the Kings County Electric Light and Power Co., Brooklyn, N. Y. He contended that he transferred these shares to his wife when he was appointed Public Service Commissioner, but Governor Whitman held that there was no evidence of the transfer, and is reported to have said that he "did not believe a transfer within the meaning of the law was ever made." The commissioners are appointed for six-year terms, and Mr. McCall had served about half his term. Previous to his appointment as a member of the Public Service Commission he was a Supreme Court Justice.

OBITUARY

Archibald Colter, contractor, and for many years Superintendent of the Cincinnati Street Cleaning Department, died at his home in that city Nov. 24 from apoplexy. He was 65 years old.

Col. W. P. Rend, President of the Rend Coal Co., of Chicago, died suddenly at the age of 75 in that city Nov. 30. Col. Rend shipped the first train load of coal out of Columbus on the Hocking Valley R.R. 40 years ago and made a fortune in the coal and oil business. He was a native of Ireland and served in the Civil War.

James I. Ayer, M. Am. Inst. E. E., General Manager of the Simplex Electric Heating Co., Cambridge, Mass., and formerly President of the National Electric Light Association, died Nov. 27 at 61 years of age. Mr. Ayer invented many electrical appliances and had charge of the installation of the municipal lighting plant at St. Louis, Mo.

Frederick Warren Dodge, Founder and President of the F. W. Dodge Co., of New York City, died at his home in that city Nov. 10. He was born in Melrose, Mass., in 1864 and was educated in the public schools of Newton, Mass. Mr. Dodge founded the F. W. Dodge Co. in Boston in 1891, and the following year he opened a branch office in New York. In 1896 he formed a partnership with Clinton W. Sweet, publisher of the "Arichitectural Record," the "Record and Guide" and "Sweet's Catalog." Shortly afterward the head office of the company was transferred to New York City. In 1912 Mr. Dodge purchased Mr. Sweet's interest in the company, and at the time of his death controlled some sixteen publishing enterprises in New York and elsewhere.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 7-10. Annual convention in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN ASSOCIATION OF ENGINEERS.
Dec. 10 and 11. Convention in Chicago. Secy., Arthur Kneisel, 29 South La Salle St., Chicago.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 13-15. Annual meeting in New York. Secy., Percy H. Wilson, Bellevue Court Bldg., Philadelphia, Penn.

SECOND PAN-AMERICAN SCIENTIFIC CONGRESS.
Dec. 27-Jan. 8. Washington, D. C.

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 28. Annual meeting in Oklahoma City. Secy., H. V. Hinckley, Oklahoma City.

AMERICAN CIVIC ASSOCIATION.
Dec. 28-31. Annual convention in Washington, D. C. Secy., R. B. Watrous, Union Trust Bldg., Washington, D. C.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 3-6. Seventh annual convention in Washington, D. C. Secy., C. R. Marsh, Brattleboro, Vt.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS.
Jan. 17-19. Annual meeting at Billings, Mont. Secy., C. C. Widener, Bozeman, Mont.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 19-20. Annual meeting in New York City. Secy., C. W. Hunt.

NATIONAL DRAINAGE CONGRESS.
Jan. 19-21. Annual meeting, Cairo, Ill. Vice-Pres., Edmund T. Perkins, First National Bank Bldg., Chicago.

ILLINOIS CHAPTER: AMERICAN WATER-WORKS ASSOCIATION.
Jan. 25-27. Annual meeting, University of Illinois, Urbana. Secy., Dr. Edward Bartow, Urbana, Ill.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 26-28. Annual meeting, University of Illinois, Urbana, Ill. Secy., E. E. R. Tratman, Wheaton, Ill.

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 22-25. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nassau St., New York City.

Brooklyn Engineers' Club—At the annual meeting held on Dec. 9 at 8:30 p.m., the following officers were elected: President, Ernest M. Van Norden; treasurer, Harry E. Funk; directors, Bernt Berger and Carroll S. Dunphe; secretary, Joseph Strachan, 117 Remsen St.

American Concrete Institute—The annual convention will be held in Chicago, Feb. 14-17, 1916, the exact location of the meetings to be announced later. The Nominating Committee has filed a ticket for the coming election, with Leonard C. Wason, of Boston, continued as president and H. C. Turner, of New York, as vice-president.

The Engineers' Club of St. Louis will hold its annual dinner on Jan. 26 in conjunction with the Associated Engineering Societies of St. Louis. Elmer L. Corthell will be the guest of the evening. At a recent meeting of the Engineers' Club it was voted to devote one meeting a month to military engineering. Major Willing, Corps of Engineers, U. S. A., will give a series of four lectures before the Club.

American Road Builders' Association—The thirteenth annual convention of the American Road Builders' Association, scheduled to be held in Pittsburgh in the week of Feb. 22, has been postponed to the week of Feb. 28, the closing day being Mar. 3. The Sixth American Good Roads Congress will be held coincidently and under the auspices of the association, as will also the Seventh National Good Roads Show of Machinery and Materials. The technical sessions will commence on Tuesday morning, Feb. 29, continuing on Wednesday, Thursday and Friday.

New Jersey Sanitary Association—The activated-sludge process of sewage treatment was the leading engineering feature of the fifty-first annual meeting of this Association, held at Lakewood, N. J., Dec. 3 and 4, 1915. The discussion was opened by W. T. Carpenter, chemist, Brooklyn Sewage-Experiment Station, New York City, who reviewed the work done at Brooklyn and elsewhere. (See "Engineering News," Apr. 1, July 1, July 15, 22 and 29, and Dec. 2, 1915.) The discussion of this paper was opened by Geo. W. Fuller, New York City, whose deductions from personal observations at the Milwaukee sewage-experiment plant are printed elsewhere in this issue. M. N. Baker, of the editorial staff of "Engineering News," characterized the process as most promising and perhaps revolutionary, provided it proves to be economically feasible. Federal experiments with small sewage-treatment plants at Washington, D. C., were outlined by Leslie C. Frank, Sanitary Engineer, United States Public Health Service. Imhoff tanks for domestic sewage appear to need steeper sloping sides than those for city sewage. Both scum formation and boiling occurred in the Imhoff tanks in July, but might perhaps be obviated by changes in design. The tank effluent created no nuisance on sand filters. Chester H. Wigley, Chief, Bureau of Engineering, New Jersey State Department of Health, opened the discussion. He said engineers do not favor Imhoff tanks for small plants because they require more attention than do the old-style tanks. In a paper on "The United States Public Health Service and the Shellfish Problem," Surgeon H. S. Cumming stated that more study of the subjet is needed and the studies should partake more of a practical sanitary survey than of the laboratory. This point was endorsed by R. B. Fitz-Randolph, Assistant Director, New Jersey Department of Health, who stated that since oyster protection was undertaken four years ago conditions had been greatly improved so that now there are few oyster areas subject to pollution in New Jersey.

International Road Congress—The program of the so-called International Road Congress, to be held at the Hotel Bancroft, Worcester, Mass., Dec. 14-17, includes the following papers:

Tuesday, Dec. 14—"The Development of Improved Highways in Canada and What It Means to the Dominion," by Hon. W. A. McLean, Department of Public Works, Toronto, Ont.; "What the United States Is Doing for the Good Roads Movement," by Logan Waller Page, Director of the United States Office of Public Roads and Rural Engineering.

Wednesday, Dec. 15—"History of Highway Development in Massachusetts," by Wm. E. McClintock, Treasurer of the Winnisimmett Co., Chelsea, Mass.; "Brick Roads," by Will P. Blair, Secretary of the National Paving Brick Manufacturers' Association; "The Merits of Natural Asphalt Roads," by Clifford Richardson, Consulting Engineer, Barber Asphalt Co.; "The Merits of Refined Asphalt Roads," by Leroy M. Law, Chemist, United States Asphalt Refining Co.; "City Pavements," by Geo. W. Tillson, Consulting Engineer of the Borough of Brooklyn, N. Y.; "Selections of Type for Road Surfaces," by W. W. Crosby, Consulting Engineer, Baltimore, Md.; "The Necessity of Scientifically Trained Engineers in Highway Construction," by Dr. Ira N. Hollis, President of Worcester Polytechnic Institute; "Concrete Bridges vs. Steel and Wood," by J. R. Worcester, Consulting Engineer, Boston, Mass.

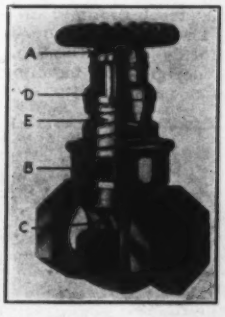
Thursday, Dec. 16—"The Selection of Materials for Highway Construction," by Dr. Joseph Hyde Pratt, State Geologist, North Carolina; "Financing City Streets," by Nelson P. Lewis, Chief Engineer of Board of Estimate and Apportionment, New York City; "Providence and Her Highway Department," by Joseph W. Gainer, Mayor of Providence; "Milwaukee County Concrete Roads," by Herbert R. Kuelling, Highway Commissioner; "Boston's Experience with Various Types of Street Paving," by James M. Curley, Mayor of Boston; "Precautions Adopted by Dominion Cities Against Extreme Climatic Changes in Building and Maintaining Streets," by Thomas Cote, Commissioner of Streets, Montreal; "The Organization of Highway Departments," by W. H. Connell, Chief of Bureau of Highways and Street Cleaning of Philadelphia.

Friday, Dec. 17—"The Automobile and Its Relation to Good Roads," by George C. Diehl, Buffalo, N. Y.; "The Type of Pavements Now Being Laid in New York State Highways," by Edwin Duffy, Commissioner of New York State Highway Department; "Improved Granite Pavements," by Henry Welles Durham, New York City; "The Ideal Road for the Motorist," by Lewis D. Speare, Cambridge, Mass.; "The Interest of the National Chamber of Commerce in the Good Roads Movement," by John H. Fahey, Boston, Mass.; "Canada as a Country for Motorists," by W. H. Danderand, Montreal; "Relation of Motor Trucks to Permanent Highways," by Wm. R. Smith, President, Lane Construction Co., Meriden, Conn.

Appliances and Materials

High-Pressure Valve with Cast-Iron Spring

Two special features of the high-pressure valve shown herewith are the entire absence of packing and the use of a cast-iron spring. This application of cast iron is novel. The springs, which are made under the Knudsen patent, have no temper, so that heat does not affect them. Test springs show no change in tension or resilience after having been in regular use for three years.



HIGH - PRESSURE UNPACKED VALVE

The nonrising handle swivels on the shoulder A and is independent of the main valve stem. A square socket in the handle turns a shank, the lower end of which fits over a square head on the main threaded spindle B. This head moves up and down in the recess of the shank as the valve C opens and closes. Between the rigid and revolving shoulers at D is a grooved ring of bearing metal, which forms a constant seat and prevents the steam or water from rising above it. The purpose of the spring E is to maintain a tight contact between the shoulders and the grooved ring. The spring was tested to 10,000,000 deflections in a machine and showed no set, calipering the same before as after the test. Many of the valves are in use.

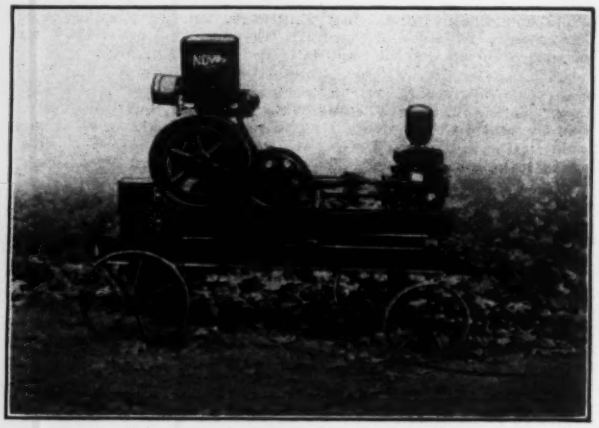
The valve is for use with high-pressure steam, water, gas and air, and also for ammonia. It is manufactured by the Universal Valve Co., 910 South Michigan Ave., Chicago, which has also the sole right to make the springs previously described.

* * *

Small Pumping Unit for Contractors

A small portable pumping unit of a very serviceable type for construction work is shown in the illustration. It is so light and compact that it may be drawn on hard road by a

single man, although of course it is not intended to be so hauled generally. The unit is designed on lines similar to those of the larger units which the maker, the Novo Engine Co., of Lansing, Mich., has been manufacturing for some time past, known as Type U pumping outfits. The unit pictured consists of a single-cylinder gasoline engine geared to the



SMALL PORTABLE PUMPING UNIT FOR CONTRACTOR'S USE ON CONSTRUCTION WORK

crankshaft of a small piston pump especially designed for high pressures. The following table gives the specifications for these small outfits:

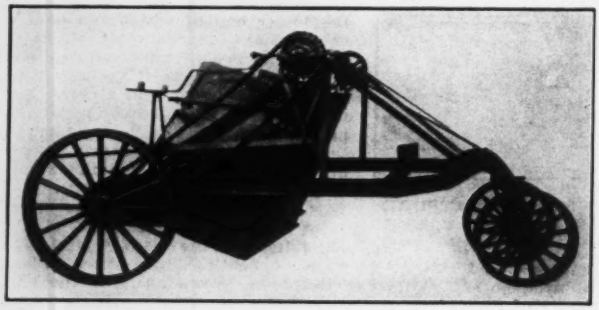
No.	Hp.	Pump Cyl. Diam., In.	Pump Stroke, In.	Suct. and Disch., In.	Cap., Gal. per Hr.	Pressure, Lb.	Bare Wt., Lb.	Shipping Wt., Lb.
61	Jr.	2	5	1	400	155	370	445
62	1½	2	5	1	400	230	415	490
63	1½	3	5	1½	900	100	425	525
64	2½	3	5	1½	1,000	150	590	700
65	2½	4	5	1½	1,800	85	640	750
66	4	4	5	1½	1,400	180	790	915
67	4	5	5	2	2,200	115	940	1,150
68	6	5	5	2	2,200	170	1,240	1,500

The smallest size of pumping outfit is claimed to deliver 400 gal. per min. against a head of 50 ft. through 5,000 ft. of 1-in. pipe or 15,000 ft. of 1½-in. pipe. Against a head of 300 ft. it is claimed to deliver 400 gal. per min. through 600 ft. of 1-in. pipe or 2,000 ft. of 1½-in. pipe.

* * *

Four-Wheel Scraper for Snow Removal

Wheel scraper-excavators of the "Maney" four-wheel type, made by the Baker Manufacturing Co., Springfield, Ill., are proving a practical device on road and street grading, railway excavation, quarry stripping, etc. These have been made with scraper-bucket or pan capacities of ½ and 1 cu.yd. A new scraper of the same type, especially designed for handling snow, is now on the market. It has a pan capacity of 4



MANEY FOUR-WHEEL SNOW SCRAPER

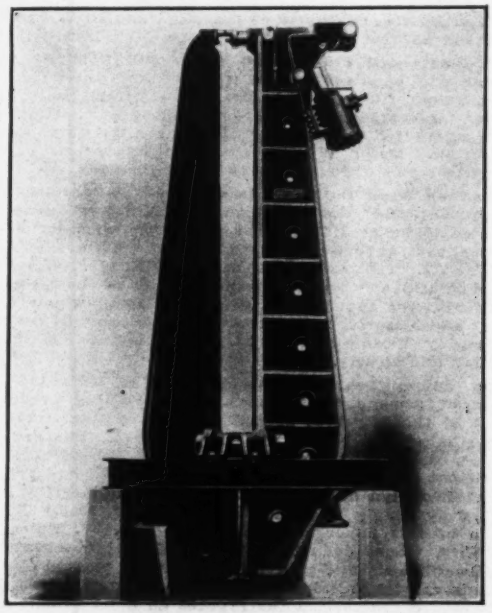
cu.yd. and can be easily handled by two horses. The illustration shows the scraper in carrying position. A lever on the right-hand side of the machine (shown in illustration) throws out the spool clutches and allows the pan to drop into loading position. A movement of the lever in the opposite direction stops the pan at any point. The pan turns and swings about an axis at one edge of the pan, which is suspended by chains to the scraper frame. A foot-lever throws in the rear wheel clutches, and the chain-driven windlass winds up chains attached to the two upper corners of the pan, raising it to the carrying position shown in the illustration. A second hand-lever stops the raising of the pan at any elevation, or an automatic device stops the windlass at any desired point. The dumping lever is operated by the driver's left hand and arm and raises the end gate, permitting the snow to slide out between the rear wheels.

The Baker Manufacturing Co. also makes a snow plow that may be attached to the front of any motor truck and a four-wheel trailer plow to be attached to the rear of the truck by an offset hitch. The plows and wheel scraper are designed to be used in conjunction, the plows pushing the snow into winrows and the scraper loading and hauling it away with little or no expenditure of hand labor.

* * *

Largest Pneumatic Riveter

What is claimed to be the largest pneumatic riveter yet constructed has recently been completed by the Hanna Engineering Works, 2059 Elston Ave., Chicago. The machine, shown in the accompanying view, weighs 40 tons, has a reach of 21 ft. and can exert a pressure of 100 tons on the rivet die with air at 100 lb. per sq.in. It is intended to replace troublesome hydraulic machines for high-pressure steam-tight work. The riveting movement is accomplished by a combination of toggles, levers and guide links until proper pressure is reached, when further travel of the die is



LARGEST PNEUMATIC RIVETER

made by a simple lever movement. The total cylinder travel is 22 in. and the die movement 5¾ in. The toggle action goes with the first 11-in. cylinder travel and 4¾ in. of die movement.

* * *

Extra-Strong Road Grader

A road grader especially constructed for hauling with tractors or steam road rollers has recently been placed on the market by the Western Wheeled Scraper Co., Aurora, Ill. Heavy Z-bars are used for the main frame and all rigid connections are made with ¾-in. rivets instead of bolts. The front wheels are 34 in. in diameter, made of steel with staggered spokes, and the rear wheels are 44 in. in diameter. The grader blade is not rigidly attached to the blade beams but has a lateral play of 22 in. in either direction. This adjustment of the blade is automatic and is controlled by the position of heavy stay chains. It is designed to bring the point of greatest resistance on the cutting edge in line with the direction of draft and thus prevent the tremendous leverage and strain which rack most tractor-drawn machines. An 18-in. extension is provided for each end of the blade. This is of special shape for cutting new or cleaning out old ditches, undermining embankments or filling in old ditches. With this attachment the machine will cut to a maximum of 4 ft. outside of the wheels. This grader is known as No. 10. It weighs 6,400 lb. and is 18 ft. over all.

Engineering News

VOLUME 74 DECEMBER 16, 1915 NUMBER 25

Replacing Water-Main Bridge with Concrete Arch

In the City of Washington there is now being built a long-span concrete arch bridge which is interesting not only for its structure and appearance but also because it incloses one of the unique bridges of this country—the old water-main arch which for many years carried the entire water-supply of the city across Rock Creek on the line of Pennsylvania Ave. This arch, which is shown in Fig. 1, was built in the early fifties of the last century as the main line of the Washington Aqueduct, and until the construction of the tunnels to the reservoirs on the north and east of the city, it conveyed all the water to the principal section of the city. Since these reservoirs were built the mains have been used only to take back filtered water from the plant east of the city to that section lying west of Rock Creek valley. While primarily intended for an aqueduct, the creek crossing was also utilized as a highway bridge and for many years formed the only connection between the two parts of the city.

As shown in Figs. 1 and 2, the old bridge consisted of two 4-ft. mains made up of flanged cast-iron pipe arched to a 200-ft. span and carrying through the medium of some very peculiar wrought-iron bracing a timber floor forming a 26-ft. highway. The pipes were special castings of 2-in. metal with heavy bolted flanges covered with the ornamental bands shown in the view. The spandrel frame was mostly of wrought-iron I-beams. In all the years this pipe has been in service its leakage has been practically negligible.

The demands of traffic required a new bridge. At the same time it was felt desirable to conserve the old water-main arch, mainly for carrying an emergency raw-water supply from the river in case the filtration plant

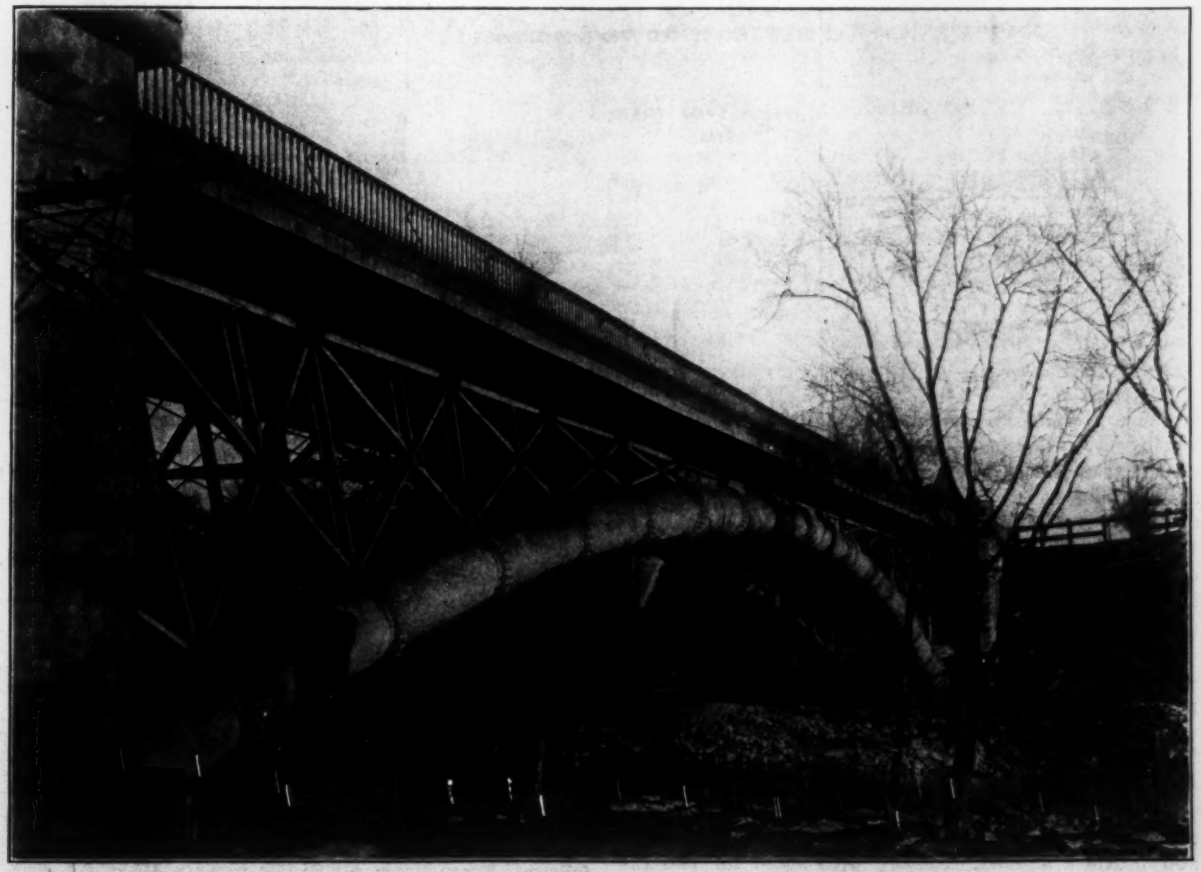


FIG. 1. OLD COMBINATION WATER-MAIN AND HIGHWAY BRIDGE ACROSS ROCK CREEK AT WASHINGTON, D. C.

or its connecting tunnels were ever put out of service. Consequently, a design for a new bridge was prepared which utilized the old abutments and concealed—though it did not support—the old arch. In this bridge, which is now under construction, the pipe arch remains self-supporting.

The right-hand half of the elevation in Fig. 2 shows the new bridge, and the other drawings in that figure illustrate the way in which the old main is cared for. The new arch is of reinforced concrete, with a 204-ft. clear span and 31-ft. rise. On account of conditions dictated by the present topography and the proposed location of a new parkway which passes under the bridge, each new arch rib has a separate abutment block, which is carried to solid rock through the masonry of the old abutment. The showing faces and balustrade of the new bridge are of cut granite.

The pipe arches in the old bridge were connected by a thorough system of counterbraces, which interfered somewhat with the layout of the new bridge. It was felt, however, that some cross-bracing of the pipes was necessary, so the bracing shown in detail in Fig. 2 was adopted. All the old bracing was removed and new struts were fitted into bands placed around the pipes.

In construction, all of the old bridge except the pipes was removed and the new concrete poured into forms

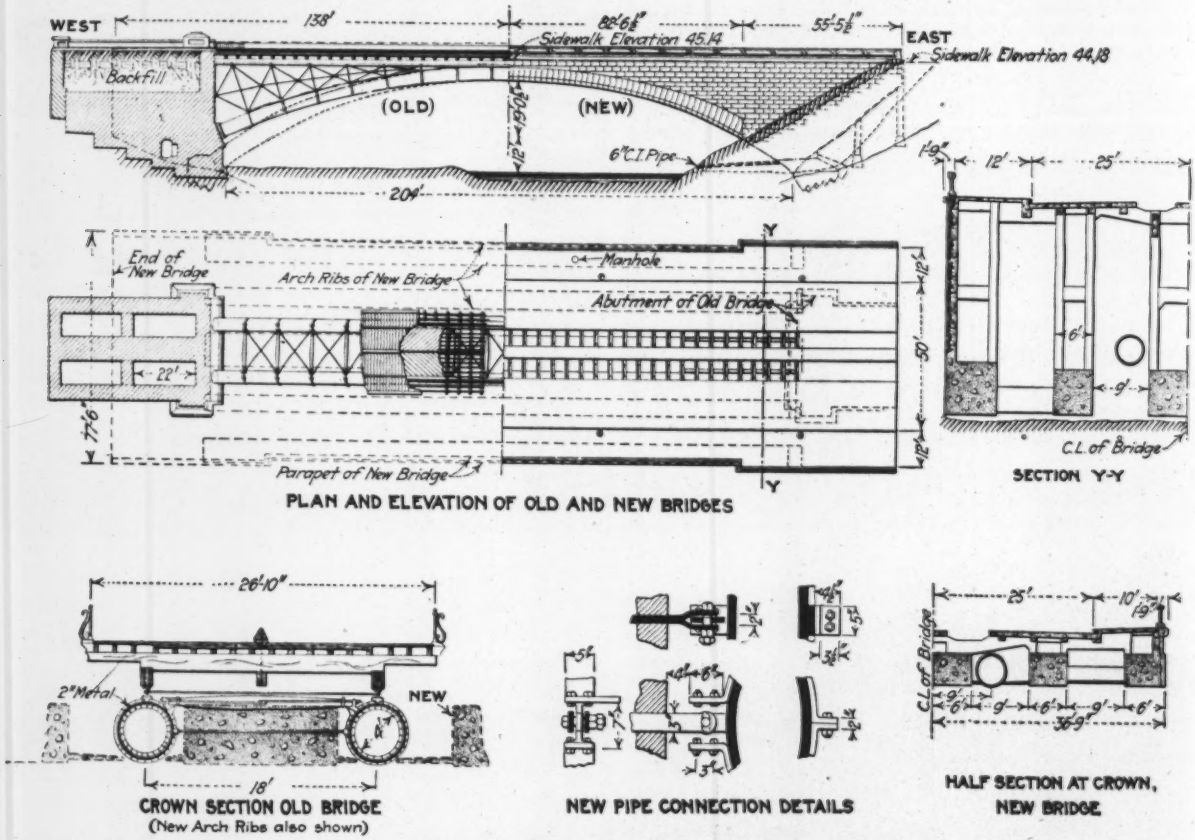


FIG. 2. DETAILS OF NEW AND OLD PENNSYLVANIA AVE. ROCK CREEK BRIDGES, WASHINGTON, D. C.

it was not possible to clear the arch to the old abutments, which were utilized also for the new abutments; a false abutment face was therefore built in front of the real abutment on each side. Thus the showing arch is only of 164-ft. span and 19-ft. rise.

The new arch is made up of five ribs dimensioned as shown in Fig. 2 and spaced so as just to avoid the water mains of the old arch. In elevation the new arch is curved so as to conceal the pipes, and the five ribs are connected by an intrados shell which not only serves as cross-bracing but also completely covers the pipes except for a very short distance near the crown where the lower surface of the pipes comes too near the intrados of the concrete arch. For this short length the pipe will be painted to resemble the concrete.

The roadway of the new arch, carried on reinforced-concrete spandrel columns and girders, is 70 ft. wide, and provides a 50-ft. roadway with space for two car tracks and two 10-ft. sidewalks. As shown in the plan resting on regular timber centers footing in the creek bed and valley.

The bridge was designed and is being built, under the direction of David E. McComb, Engineer of Bridges of the District of Columbia, by the Hardaway Construction Co., of Columbus, Ga. Its total cost will be about $125,000. It will be used both for a highway and street railway crossing.

The Expenses of the Sanitary District of Chicago for the year 1914 amounted to $7,316,200. Of this total, $2,325,348 was for construction work (exclusive of land), $1,706,000 for retiring bonds, and $1,508,605 for the electrical department. The largest item in construction work was $1,322,051 for the Calumet-Sag channel. The receipts for the year were $6,581,437, of which $5,088,874 was in taxes. With a balance of $1,313,117 on hand at the end of 1913, the total receipts for 1914 were $7,894,554, leaving a balance of $578,355. For the whole period of the existence of the Sanitary District of Chicago, to the end of 1914, the financial operations have been as follows: Expenditures, $76,555,179; receipts, $80,642,472; balance (including money due from the city, etc.), $4,087,293.

Automatic Pumps in Boston Prevent Sewer Flooding*

By E. S. Dorr†

A section of the South End in Boston has remained without a complete system of drainage for the past 50 years. This area comprises several blocks in the vicinity of Albany St. and Union Park. The territory contains about 190 acres laid out on the alleyway plan. The streets are below high tide, and the cellars are below high-water level in the main sewers. The sewers are built on a combined scheme delivering dry-weather flow into the East Side intercepting sewer in Albany St. and storm flow into South Bay. The interceptor can carry away only a small fraction of the storm runoff, and when a long-continued rain coincides with a high spring tide, the district is badly flooded.

The peculiar conditions in this district trace back to the existence of old tide-mill ponds here. One pond was used as a receiving basin to take the discharge from the other pond at periods of high water. This basin became a huge storage reservoir protected from high tides and afforded a low outlet for sewers that were built to drain the land made by filling the flats. In time the basin became a gigantic cesspool so that arrangements had to be made to drain it. Filling in the basin itself to accommodate the crowding districts began about 1860. The plan was adopted of turning the drainage of the district into South Bay and building the main sewers large enough to afford some storage at high tide. The sewer system was adequate to discharge the storm water of heavy rains at low tide, and the storage capacity was sufficient for short, violent showers at high tide, but when a heavy rain lasted over a high tide, the storm water and sewage ran back into the low basements, yards and alleys until the next low tide. Some assistance was rendered by the connection with the intercepting sewer mentioned, but flooding was not prevented.

It was long realized that nothing effective could be done except by pumping, but in the older days this required a steam station (particularly difficult and expensive to maintain on account of the intermittent character of service), but with the development of centrifugal pumps, electric motors and automatic electric control the problem was taken up again by the City Sewer Division.

The district was already completely sewered. Only those portions of the district which suffered most were to be reached by a low-level system of sewers connecting to the pumping station. A new main sewer for the flooded district was required, and this was secured by rebuilding the Union Park St. line, an old wooden sewer in rotten condition. This was built of a peculiar section—it might be called a sewer with a horizontal septum. One sewer was superimposed on the other, the top one taking flow from street surfaces and parts of the districts high enough to drain by gravity, while the lower one cared for all those areas that would not drain at high tide, and it connected with the pumping station. The top sewer was built at the same elevation as the old line which it replaced. It discharges its dry-weather flow into the interceptor through a sump and regulator. When the interceptor is full, the storm flow goes through an overflow outlet to the South Bay, operating in all respects like the old line. The low-level section underneath the top sewer also connects with the interceptor and discharges dry-weather flow into it as long as the interceptor will receive it. When it begins to be backflooded, a tide gate closes and diverts the flow over weirs into the pump wells of the pumping station, whereupon the pumps start up automatically and eject the flow into South Bay through an outlet conduit separate from the overflow outlet of the sewer.

The station has three 36-in. and one 26-in. centrifugal pumps, giving a total capacity of 105,000 gal. per min. against a head of 13½ ft. It is the largest automatic station in the world. One 36-in. pump is regarded as a spare unit, making the normal capacity of the station 75,000 gal. per min. Each 36-in. pump is driven by a 150-hp. constant-speed induction motor taking three-phase 60-cycle current at 440 volts. The 26-in. pump has a 75-hp. motor, making the total power required for the station 525 hp. Each motor is thrown into operation by a float-actuated switch set for a fixed elevation of the sewage in the pump well.

The foundations for the station presented a problem, the underlying material for 37.5 ft. being a soft silt except for a few feet of gravel, clay and ash filling on top. There was a substratum of 3.5 ft. of stiff blue clay and under this a soft clay or silt to hard bottom at 80 ft. depth. As the pit for the substructure was sheeted with 6-in. grooved and splined Georgia pine driven to the clay stratum and as the foundation was to be a raft of reinforced concrete 3 ft. thick, it was finally determined to drive 25-ft. piles to bear a load of 8 tons each. The concrete was mixed with integral waterproofing (liquid). The treatment has been successful; a few small leaks developed, but were stopped.

The capacity of the station is not only ample, but has some surplus, since the limits of ultimate extension of the pumping system are indeterminate.

Just after the station was put in operation a phenomenal rain gave a fair test. One 26- and one 36-in. pump were called into action. The tide was falling, however, and the maximum test is yet to come with a rising tide and such a rain.

The contract price of the machinery was $35,856. The building, including substructure, cost $50,000. The total cost of the project, sewers and all, is about $400,000. Extensions in sight may add $125,000.

*From a paper before the Boston Society of Civil Engineers, Nov. 3, 1915.

†Former Chief Engineer, Division of Sewers, Boston, Mass.

A 62-Ton Traveling Stiff-Leg Derrick for the new harbor works at Valparaiso, Chile, will place massive concrete blocks and will handle a grab bucket with the auxiliary hoist. It can hoist 62 tons at a 60-ft. radius with a speed of 10 ft. per min. For 10-ton loads the speed is 50 ft. per min. with the main hoist or 60 ft. with the auxiliary hoist (single rope). The swinging is done at 190 ft. per min. (at the hook), and the traveling speed is 40 ft. per min. The foot of the box-girder mast has a ball-bearing with 50 balls 2 in. diameter in two rings. The boom, stiff-legs and sills are of box-lattice construction. For hoisting, topping and traveling there is a 10½x16-in. engine controlled by a hydraulic brake having oil cylinders. The 8x10-in. swinging engine is controlled by a foot lever. Steam is supplied by a vertical boiler. The mast is seated on a bedplate carried between two six-wheel trucks, and there is an eight-wheel truck under the heel of each stiff-leg. These trucks have 30-in. wheels and are on tracks of 5 ft. 6 in. gage. For work with the boom at right angles to the rails there are two tracks 60 ft. c. to c., but where the boom works parallel with the rails there are three tracks 35 ft. c. to c. of the outer tracks. This machine was built by Joseph Booth & Bros., of Rodley, England, for S. Pearson & Sons.

Ballasted Timber Floor for the Sibley Bridge

Solid floors with ballasted tracks are not generally used on large railway bridges, and this construction is therefore a rather notable feature of the reconstructed bridge of the Atchison, Topeka & Santa Fé Ry. crossing the Missouri River at Sibley, Mo.

The Sibley bridge was built in 1887. In 1914-15 the superstructure was renewed in order to provide for the heavier loading of modern locomotives and trains. The new bridge is designed for Cooper's E-60 loading, while the loading for the old bridge was equivalent to Cooper's E-24. This part of the railway is double track, but the two tracks are gauntleted across the bridge, as the original pneumatic caissons were too short to permit of widening the piers to carry a double-track superstructure. The bridge comprises three through-truss channel spans of 396 ft., a deck truss span of 247 ft., two deck truss spans of 172 ft. 6 in., three plate-girder spans of 80 and 100 ft. at the west and an east approach viaduct about 2,000 ft. in length.

The floor on the through-truss spans, Fig. 1, has a close deck of timbers, 4x8 in., laid flat, with every fifth timber secured to the track stringers by hook bolts. The timbers are 16 and 18 ft. long. The ends of the timbers rest upon I-beam jack stringers. Upon this deck is a bed of stone ballast, 6 in. thick at the ends of the span and 8¼ in. at the middle. This is held in place by a 6x10-in. curb timber at one side and by a raised plank walk at the other side. The walk is covered with 3 in. of stone screenings. The curb is held by straps secured to it and to the floor by lagscrews. Blocking is required around the gussets connecting the floor-beams and truss posts.

On the deck truss spans, Fig. 2, the floor timbers also rest upon the track stringers, while their ends are carried by 6x10-in. timbers laid along the chords. All the floor timbers are 18 ft. long, their ends carrying the walk, which has curbs to hold the screenings in place.

The floor on the girder spans and viaduct is of rather different construction, as shown in Fig. 3. The transverse timbers are 8x8 in., laid directly upon the girders,

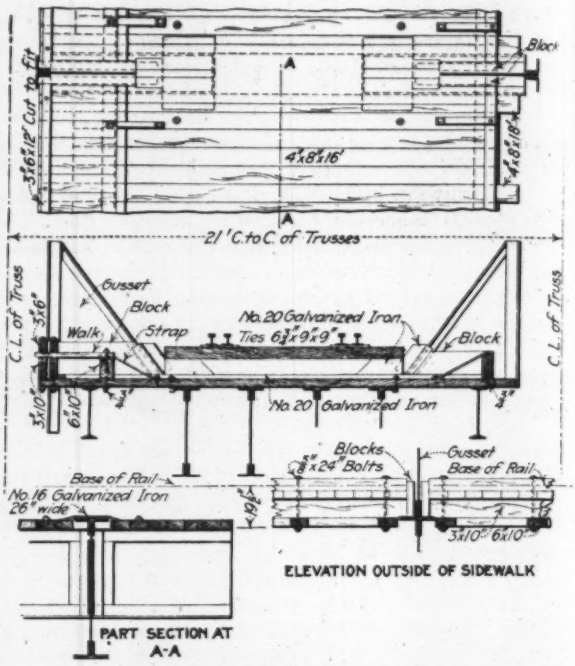


FIG. 1. SOLID FLOOR AND BALLASTED TRACK ON THE 396-FT. THROUGH-TRUSS SPANS OF THE SIBLEY BRIDGE

being bored out on the under side to fit the rivet heads. The curbs or guard timbers are 6x10 in. The floor timbers are 14 ft. long, except that every sixth timber is 16 ft. and set in 6 in. from one end of the other timbers, so as to give a projection of 2 ft. 6 in. to carry a continuous walk of three planks. This walk is covered with 3 in. of stone screenings between the guard timber and an outer curb, 2x6 in. A hand railing runs along this walk.

At intervals on the approach there are handcar platforms. Each has four timbers, 6x8 in., 24 ft. long (forming long deck timbers). The outer ends of these are supported by inclined struts footed upon the bottom chord of the girder. Across these are 3x6-in. joists carrying a floor of 2x6-in. planks, on which is a 3-in. layer of stone ballast.

All the timber is creosoted pine. Where it has to be cut for framing, the surfaces are given two coats of a hot solution composed of 1 part creosote oil and 3 parts heavy road oil.

The track on all the spans has two pairs of 90-lb. rails (gauntleted 7 in. over gage lines) on ½-in. tie-plates, long enough to carry both rails. The ties are 9x6¾ in., 9 ft. long, spaced 18 in. c. to c. The depth of stone ballast is 6 to 6¾ in. on the 8x8-in. floor of the deck spans and viaduct and 8¼ in. on the 4x8-in. floor of the truss spans. The weight of track, ballast and deck is about 2,100 lb. per lin.ft. on all spans.

It is of interest to compare the economy of the ballasted deck with that of the ordinary open deck. After

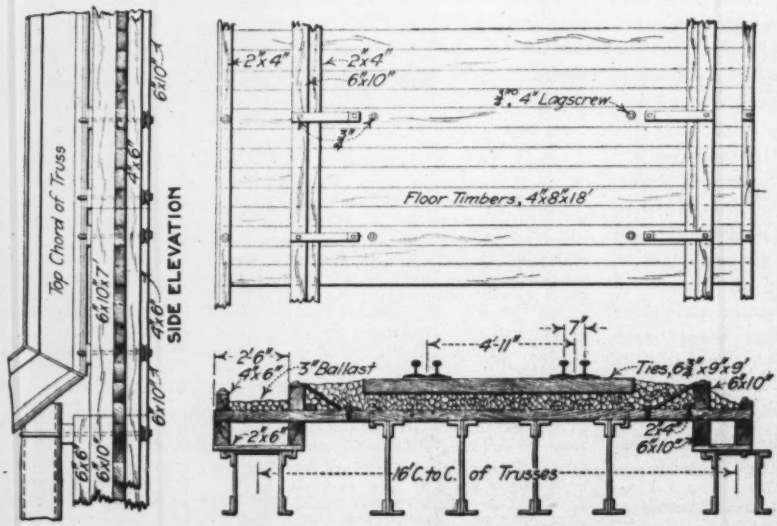


FIG. 2. SOLID FLOOR ON DECK TRUSS SPANS OF THE SIBLEY BRIDGE

aking into account the interest on the increased cost of the ballasted deck and the cost of lining and surfacing track, the total annual maintenance charge for this

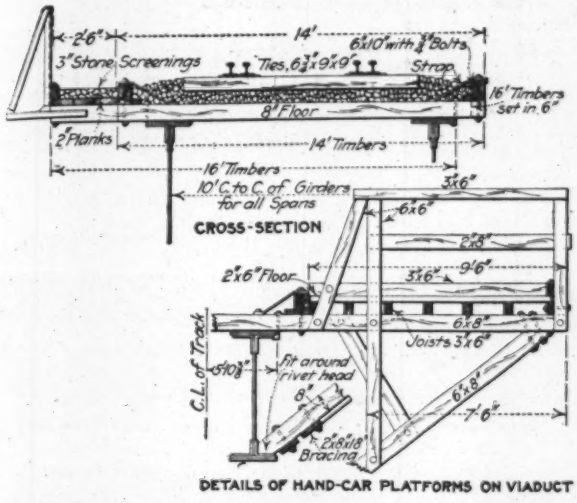


FIG. 3. SOLID FLOOR ON GIRDER SPANS AND VIADUCT APPROACH OF THE SIBLEY BRIDGE

construction shows a very good margin of profit over that for the open-deck construction on the old bridge.

The bridge (with its solid floor) was designed by A. F. Robinson, Bridge Engineer, Atchison, Topeka & Santa Fé Ry. system.

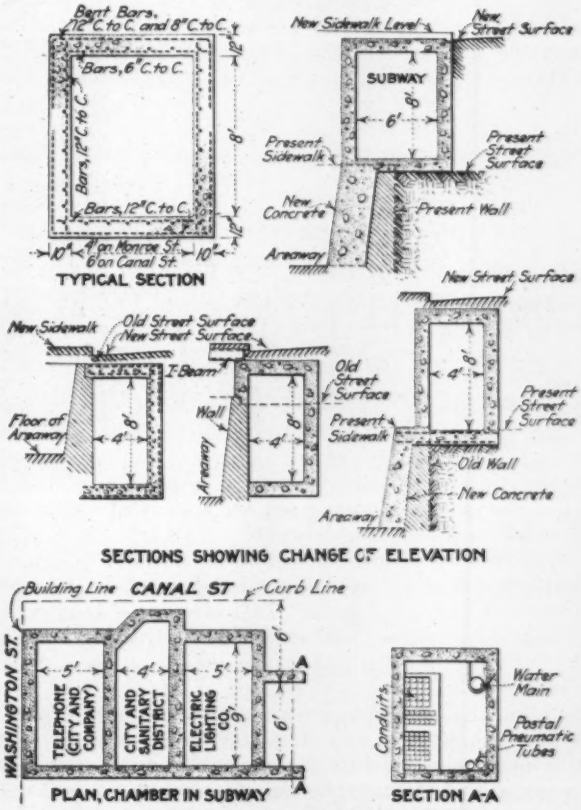
Chicago's Public-Utility Subway

A utility-service subway is now being constructed at Chicago as one of the auxiliary works for the new union railway station at Canal and Adams St. It is of rectangular section, 4 and 6 ft. wide inside and 8 ft. in clear height, as shown in the drawing herewith. It is of reinforced concrete, with 10-in. sides and 12-in. roof and floor, the latter having a fall of 1 in. at the center for drainage. The reinforcement consists of ½-in. deformed bars. The subway will contain water pipes (suspended from the roof), pneumatic mail tubes and electric conduits. The latter will provide for the city's lighting, bridge operating and fire- and police-alarm services, the telephone and electric-light companies and the services of the Sanitary District of Chicago.

The subway is about four blocks in length and is in the roadway, with one side adjacent to the curb line. A curious feature in the construction is that part of the work is built above the present street grade. This is due to the fact that the construction of the new station will involve raising the grade of adjacent streets. In this way one side of the subway is built on the existing walls at the curb line (for sub-sidewalk areas). These walls are faced with ½-in. cement mortar when they form the side of the subway, and are strengthened by concrete on the rear side where necessary. Some of the typical sections of this part of the work are shown in the drawing. Manholes are provided at intervals. At Washington and Canal St. there will be a vault for the various utilities, as shown in the lower section of the drawing.

Part of the work was built in the open, a steam-operated portable concrete mixer being placed in the street and concrete distributed by wheeled carts on buggies. Where the subway runs along the side of the Chicago & Northwestern Ry. terminal, the concrete was obtained from a plant erected for work on the union station, being spouted across the street to a hopper from which the buggies were filled. The crossing of Madison St., with its heavy traffic, was effected by tunneling under the roadway, timbers being placed to support the street-car tracks.

The cost is paid mainly by the Union Station Co., but the city pays for a portion of it and the plans are approved jointly by Thomas Rodd, Chief Engineer of the



UTILITY-SERVICE SUBWAY IN CHICAGO

company, and John Ericson, City Engineer. The construction is under the direction of A. J. Hammond, Assistant Engineer for the Union Station Co. The contractor is the W. J. Newman Co., of Chicago, which is doing the work in connection with other work auxiliary to the building of the new station.

Six-Wheel Motor Trucks and motor buses are suggested by John Riekie, writing in "The Engineer," of London, as a means of reducing the destructive effects of such vehicles upon the public roads. He disapproves of the twin-wheel (or broad wheel with two separate tires) now commonly used, as he considers it destructive to both the tires and the road, since under certain conditions of surface each tire may have to carry 50% more load than that for which it is designed. Instead of the six tires on four wheels he would have them on six wheels, while for very heavy loads he prefers eight wheels. The springs could be connected by equalizing levers, as in railway practice, so as to give an equal distribution of the load upon the wheels. No plans are given, but it is stated that such a wheel arrangement can be designed without difficulty, and that part or all of the wheels could be driven, coupled or steered.

Experimental Concrete Roadway, Sacramento, California

By A. J. Cleary*

To test the permanency of concrete pavement under ordinary traffic, to investigate its adaptability to local climatic conditions and to determine the most economic design, a 3,000-ft. stretch of experimental pavement was laid on the county road between Sacramento and Riverbank, Calif., in September, 1912. Climatic conditions in this section show less fluctuation than in Eastern states, the extreme temperatures ordinarily being between 35 and 100° F.

On the road selected traffic conditions are such as would be expected on any country thoroughfare leading into a large city. Farm wagons traveling loaded in both directions, motor trucks, light horse-drawn vehicles and automobiles all use the road in numbers which constitute "medium" traffic. About 100 heavy wagons is an average for most days.

Construction Methods of Experimental Pavement

The pavement has a uniform width of 18 ft., with a crown of 3 in., sloping to the sides at a uniform rate of $\frac{1}{8}$ in. per ft. For half the length of the roadway the subgrade below the westerly portion is a heavy clay loam, while the easterly end was laid over an existing macadam road. All of the subgrade, after being trimmed, was thoroughly compacted by sprinkling and rolling with an 8-ton steam roller. To prevent the absorption of water from the concrete the subgrade was again well moistened just before placing the concrete.

Portland cement which complied with the standard tests prescribed by the American Society of Civil Engineers was used throughout. Two varieties of local sand —one sharp, coarse and well graded, from the Yuba River; the other fine and interspersed with mica, from the Sacramento River—were used.

Six of the sections tested had a thickness of 6 in.; two were 5 in. and three 4 in. thick. On four sections a light wire-mesh reinforcement was used. This had a sectional area of 0.1 of 1% to 1% of the cross-sectional area of the concrete. Its function was not to withstand shrinkage stresses but rather to bind the concrete.

Four types of expansion joints were tried—plain joints, oiled, spaced at 10, 20, 30 and 40 ft. respectively; joints of tar paper; ¼-in. joints filled with bitumen, and ⅜-in. joints with edges protected by soft steel plates, and one section had no expansion joints. Joints of the first three types were laid diagonally in some places and at right angles to the axis of the road in others. The metal-protected joints were laid at right angles to the roadway.

The pavement surface was of six varieties—(a) roughened with wire brooms; (b) pitted with embossed tamper; (c) checkered, grooved pattern, checks 6 in. square; (d) plain concrete surface; (e) sanded surface; (f) surface covered with a $\frac{3}{16}$-in. coat of bitumen and fine rock screenings.

The sections of experimental pavement run from east to west. The condition of each section in September of the present year is briefly described as follows:

Section 0—Length, 600 ft.; thickness, 6 in.; mixture, 1:2:5; reinforcement, none; expansion joints of oiled paper and plain oiled joint; surface grooved with tampers. This section is in excellent condition, shows no evidence of disintegration, cracking or chipping at the expansion joint. It is the best-appearing section on the entire road.

Section 1—Length, 200 ft.; thickness, 6 in.; mixture, 1:2½:6; reinforcement, none; expansion joints, ¼-in. spaces filled with bitumen and screenings; surface oiled and sanded. Over one-half of the surface carpet is worn off in patches. The exposed concrete surface is in good condition and no cracks can be seen. The section would have been better had no oil been placed upon the surface.

Section 2—Length, 200 ft.; thickness, 6 in.; mixture, 1:3:6; reinforcement, No. 12 wire mesh; expansion joints, ¼-in. spaces filled with bitumen and screenings; surface, ⅜ in. thick, of bitumen and screenings. About half the asphalt surface has been worn off and the exposed concrete shows no signs of deterioration, nor any variation in wear. No cracks appear in the entire section.

Section 3—Length, 300 ft.; thickness, 6 in.; mixture, 1:2½:5½; reinforcement, none; expansion joints, ¼-in. spaces filled with bitumen and screenings; surface, ⅜ in., bitumen and screenings. About half the bituminous surface has been worn off and the concrete surface shows signs of wear. Several of the expansion joints are cracked at the edge and exposed; one especially poor spot is shown in Fig. 2. Transverse cracks appear across the surface, which is somewhat uneven. Evidently the poor

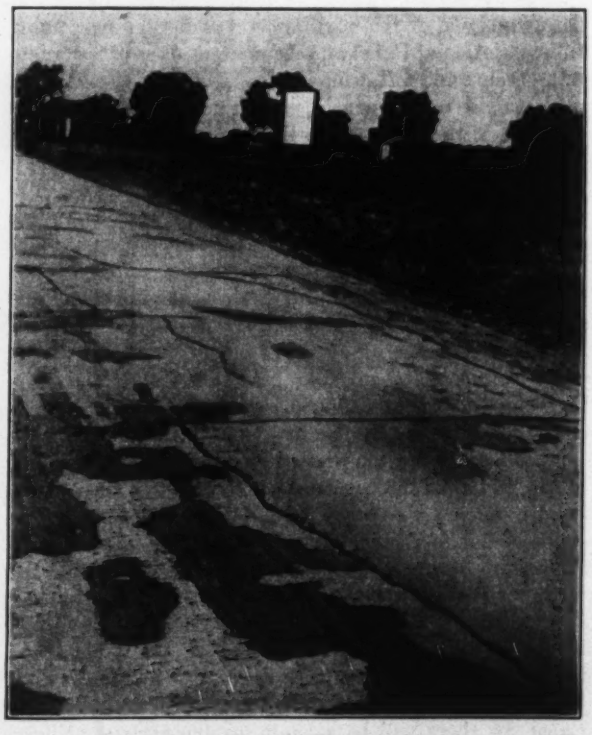


FIG. 1. SECTION 6 OF THE EXPERIMENTAL CONCRETE ROAD, RIVERBANK, LOOKING WEST

*Assistant City Engineer, San Francisco, Calif.

condition of the pavement is due to the lack of sufficient cement in the concrete.

Section 4—Length, 275 ft.; thickness, 6 in.; mixture, 1:2½:6; reinforcement, none; diagonal expansion joints filled with a single thickness of tarred paper. This section is in good condition, the only defect being that several of the expansion joints are badly chipped.

Section 5—Length, 247 ft.; thickness, 4 in.; mixture, 1:2:4; reinforcement, No. 7 triangular mesh; oiled expansion joints; surface roughened with grooved tampers. This entire section is in good condition except for the slight settlement adjoining a culvert, where the subsoil apparently was insufficiently tamped.

Section 6—Length, 250 ft.; thickness, 4 in.; mixture, 1:2:4½; reinforcement, none; expansion joints, partly tarred paper and the remainder oiled; surface broomed. Fig. 1 shows the general condition of this section. Longitudinal cracks extend throughout practically the entire length, and many transverse cracks have appeared. The surface is badly disintegrated and the expansion joints badly fractured. Some of the surface was later covered with oil, which has almost entirely worn off. This section

FIG. 2. SECTION 3 OF THE EXPERIMENTAL CONCRETE ROAD, RIVERBANK, YOLO COUNTY, CALIF.

is at the beginning of the westerly half of the road, where the foundation is clay and loam.

Section 7—Length, 250 ft.; thickness, 6 in.; mixture, 1:2:5; reinforcement, none; expansion joints, oiled; surface roughened with grooved tampers and oiled. The oil covering is worn off in large patches throughout the entire section, exposing a clean concrete surface. There are several longitudinal cracks, one of which is 1 in. wide.

Section 8—Length, 260 ft.; thickness, 5 in.; mixture, 1:2½:6; reinforcement, triangular mesh; expansion joints, double thickness of tarred paper; surface broomed. This entire section presents a badly worn appearance, all parts being considerably chipped at the joints. Longitudinal and transverse cracks are frequent and the concrete is uneven, indicating rapid wear.

Section 9—Length, 270 ft.; thickness, 5 in.; mixture, 1:2½:5; reinforcement, none; expansion joints, ⅜-in. spaces 30 ft. apart, protected by soft-metal plates; surface roughened with grooved tampers. The tendency of the metal plates in this section has been to settle unevenly, causing depressions in the adjoining concrete surface, which is worn along one side of the road. Longi-

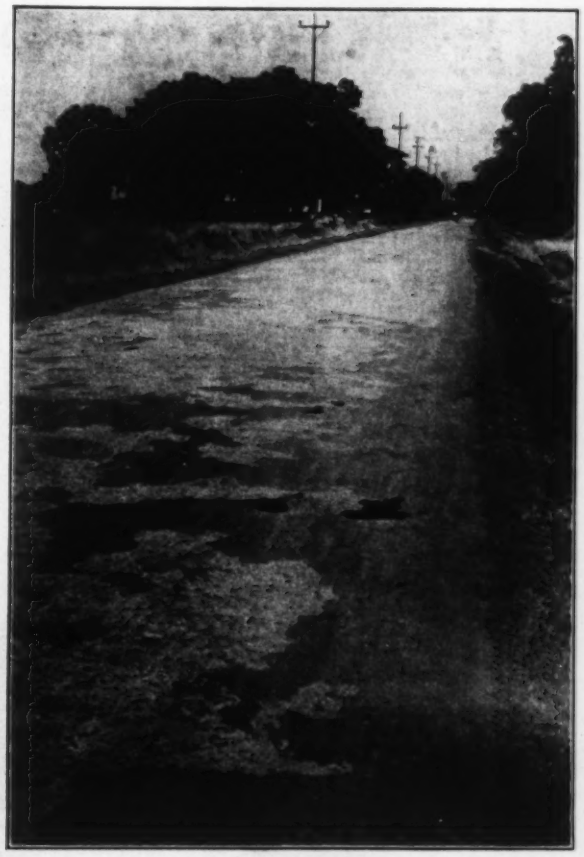


FIG. 3. SECTION 9 OF THE EXPERIMENTAL CONCRETE ROAD, RIVERBANK, LOOKING WEST

tudinal and transverse cracks are quite frequent (Fig. 3).

Section 10—Length, 217 ft.; thickness, 4 in.; mixture, 1:2:5¼; reinforcement, No. 12 wire mesh; no expansion joints; surface checkered. This section is in fair condition, very few cracks being seen.

Conclusions Drawn from Experiments

From the foregoing the effects of lean mixtures and poor foundation material, or the two together, are readily apparent. A thin bituminous carpet has proved unsatisfactory. Metal expansion joints appear inferior to a plain joint, either oiled or filled with tarred paper, transverse or diagonal. Joints should not be spaced at intervals greater than 20 ft.

It will be noted that the three 6-in. pavements (Sections 3, 4 and 7) which show deterioration are all lean mixtures and none have reinforcement. On the other hand, Section 1, constructed of an equally lean mixture and not reinforced, has stood up remarkably well. The two sections (5 and 10) of reinforced 4-in. pavement have shown quite remarkable wearing qualities, but the unreinforced section of 4-in. pavement (6) has practically all gone to pieces. This and Section 5 were both made with the poorer, or Sacramento River, sand. Sections 8 and 9, of 5-in. pavement, appear to have suffered about the same, although one is reinforced, while the other is not.

The road was constructed under the direction of Haviland, Dozier & Tibbetts, Consulting Engineers, of San Francisco. Its condition was examined for *Engineering News* in September, 1915, by H. Armstrong, Assistant Engineer, California Reclamation Bureau.

Chicago & Northwestern Ry. Valuation Methods

SYNOPSIS—This article outlines the methods of preparing and recording the mass of detailed information upon which the valuation of railway property is to be based. It gives a summary of the instructions prepared by one large railway system, but is illustrative of the methods employed by railways in general.

Railway valuation is being carried out on a large scale by the railways and the Interstate Commerce Commission, and the railways have to collect a vast amount of information from which the cost of work and the value of property may be determined. This article is a condensed compilation of the instructions issued to engineers preparing such information on the Chicago & Northwestern Ry. The field practice and organization for the work of this road were described in *Engineering News* of Oct. 28.

The work preparatory to valuation includes the examination of all structures and property, the preparation of maps and drawings and the investigation of plans and records; also the compilation and filing of all old and new data in form available for use when the actual determination of values is commenced. All this work is under the direction of a valuation committee, which includes William H. Finley, Chief Engineer, and George W. Hand, Valuation Engineer.

GENERAL INSTRUCTIONS TO ENGINEERS

The field work will consist of a complete chain survey of all property, level notes where necessary to determine grading quantities, and descriptions of bridges, buildings and other structures. The notes from these surveys will be used to compute the quantities of the various elements of property, to arrive at their value and also for the purpose of plotting. They must contain such measurements as are necessary to admit of resolving all elements of material into commercial units and of describing their character, and also must contain data as to the correct location and position of each object, so that it may be correctly shown on maps. Every page of the notes must be signed and dated. Notebooks must show names and positions of all persons in the party.

Six notebooks will be used on each survey, one for each of the following: Main-line chaining, main-line auxiliary notes, levels, side tracks, buildings and bridges.

The main-line chaining notes will be of first importance and will be the basis of other notes. The right-hand page will be for a sketch illustrating the topography of the line (approximately ½ in. to 100 ft.). The left-hand page will show the stationing. The auxiliary main-line notes include such details as the weight, brand and date of rails, kind and number of ties, kind and amount of ballast, number of track fastenings, tie-plates, etc.

CHAINING THE LINE

All tapes must be compared and checked. The party taking notes must be supplied with blueprint alignment maps and must have complete information as to the location of the zero point of chaining, also the pluses to all permanent points, land lines, monuments, etc., so that the chaining may be checked with the original chaining used on existing maps and records. Any apparent discrepancies must be investigated, and whenever this rechaining varies from the original by 10 ft. or more, an equation will be made and the original chaining resumed. These equations will not be introduced in the chaining within the limits of station grounds.

All chaining must refer to the original center line as located, and great care must be exercised in taking pluses to lines crossing the center line diagonally that the plus given is to the point where the original center line intersects the other line. In all double-track districts the original center line may be the present center between tracks or the center line of either of the present tracks. It frequently changes from one to the other, and oftentimes is neither of these lines, but a line at varying distances from the present center between tracks. The location of this line can be ascertained by reference to the record maps or by retracing on the ground and the party making this rechaining must be thoroughly informed about this before proceeding with the work.

When chaining along the rail on curves, corrections should be made to conform to the distance along the center line. These corrections must be made with such frequency as to avoid an accumulated error of 1 ft. or more, and all errors must be eliminated at the end of each curve. The difference between the distance along the rail and along the center of the track is 0.04 ft. per 100-ft. station for each degree of curvature. The difference between the distances along the center of either track and along the center line between tracks, for tracks spaced 13 ft. c. to c., is 0.11 ft. per 100-ft. station for each degree of curvature.

In chaining on grades where the amount and length of grade would introduce error greater than the probable error from other causes unavoidable, corrections should be made. This correction per 100-ft. station is equal to the per cent. of grade squared and divided by 200. This for a 1% grade equals 0.005 ft. per station. For 1 mi. the correction would be 0.26 ft. For a 5% grade the correction per station is 0.125 ft. per station and 6.6 ft. for 1 mi. The correction per 100 ft. is the amount each station should be lengthened to give the true distance along a horizontal line.

CONDITION OF PROPERTY

Notes will be taken on the physical condition of each structure, judged from the standpoint of the amount of maintenance bestowed upon it. Field inspectors will note structures above the average as "first class," those in average condition as "good" and those below the average as "fair." No other classes will be shown, but a statement should be made as to any special conditions and what is their effect on the condition of the structure.

All buildings, bridges, crossings, cattle guards, whistle posts, signals, etc., should be noted, so that they can be referred to in the auxiliary notes by pluses and the page stated on which they are shown in these notes.

GRADING ALONG THE LINE

These notes will show width of roadway at subgrade, classification of excavation and side slopes. This information is to be used with the profile in computing the quantity of each classification of grading, so that where two or more classifications exist, the notes must show the proper proportion of each class. Where conditions are such that extraordinary settlement would occur, inspectors should state the nature of the formation and make an estimate of how much settlement would take place. Careful examination should be made and notes taken of all work, such as riprapping and other protection work. Notes should be taken to show how earth could be hauled where excavation from the cuts would have to be wasted and borrow made for fills, and where earth for fills would have to be borrowed from adjacent cuts and hauled out instead of being borrowed at the side, as would ordinarily be done if conditions would permit. This will enable a proper estimate of overhaul to be made. Notes should be made of location and size of ditches, also all channel changes.

CLASSIFICATION OF MATERIALS

In addition to measurements necessary for computing the quantities of grading, notes and measurements must be made of conditions relative to the geological characteristics of cuts and fills, upon which the cost of grading depends. Primarily materials will be classified as solid rock, loose rock and earth. On account of various characteristics, however, there are wide differences in the prices for these items in different parts of the country. Other materials, such as hardpan, quicksand, cemented gravel, gumbo, etc., will require further variations in the prices. The information called for in the following paragraphs is therefore essential in establishing proper unit prices for grading.

The assistant engineer in charge of each party will personally make the necessary observations for obtaining this information. It should be recorded in the main-line auxiliary notebooks under the heading of "Grading." He must sign and date all such notes.

Where two or more kinds of material are found in the same cross-section the field notes must clearly set forth

the data necessary for computing each separately, or for approximating the percentage of each classification when accurate measurements are impossible. The character of the material from which each cut or extensive borrow-pit was made should be noted.

Where two or more formations occur in strata, as, for instance, clay loam on top of blue clay, state that the top (4 ft., for example) is heavy clay loam and the remainder tough blue clay. Sufficient examination should be made to ascertain the correct depth of the overlying loam, for in most cases it will appear to be deeper than it was in reality, owing to the fact that it has fallen down over the surface of the cut and covered part of the underlying strata.

Special materials employed in constructing the roadbed, particularly at places where the banks have been widened or the grades raised, and materials which have been applied originally as ballast, but which have settled below subgrade, and material exceptionally employed in raising track under traffic should be determined and shown separately from the ordinary materials deposited in the customary manner in normal construction.

Care should be exercised to discover all evidences of hard material, such as hardpan, cemented gravel and indurated clay; also other material difficult to handle, such as gumbo or marl. If material resembles any one of these, but is not definitely known to be such, it may be stated that it resembles hardpan or gumbo, etc.

Where boulders are prominent, it is to be presumed that they were encountered in making the cuts, and sufficient note should be made to admit of classifying a certain amount of material in the cut as rock to allow for them. For example, make a notation: "Classify the cut as 2% loose rock, 1% solid rock on account of boulders."

Where rock is encountered, especially solid rock, it should be generally classified as sandstone, limestone, slate, shale, granite, basalt or by some other easily defined classification. Rock that cannot be readily classified geologically by inspection should be generally described as to appearances, hardness, density, etc. The general structural characteristics should be noted, so as to afford some idea as to whether it would be comparatively expensive to excavate for that particular kind of rock. Note whether stratified rock is in thick or thin strata; note the color of the rock and state whether sandstone appears to be a soft or a hard variety. Note whether rock is dense or porous, and whether it has the appearance of cleavage, so far as these things are visible on inspection.

Precautions should be taken to note evidence of wet cuts, the presence of quicksand or other conditions that would make excavation more difficult. Where such conditions are observed, close attention should be paid to requirements, such as blind drains, extra-deep ballast, subsequent heavy ditching and the condition of adjoining fills, to discover evidences of extraordinary settlement, sloughing of material or mud slides.

The present condition of side slopes should be noted, stating whether they have been badly eroded or not. If cuts are badly gullied, note the average depth of gully. Note whether side slopes are protected by vegetation or are bare. Such information is essential in estimating the cost of solidification of the roadbed, which expense depends greatly on the manner in which the exposed slopes withstand the action of the elements.

In all places where extra work appears to have been necessary to make the fill, the situation should be carefully studied. It should be remembered that when every possible thing is discovered, there will still be little actual evidence of expense often necessary on account of heavy settlement, slipping of material, washouts, etc., so that the slightest indication of anything of this sort should be thoroughly investigated. Instead of taking a few yards of riprap for what it appears to be, and going on without further investigation, it should be looked upon as evidence of a bad place where perhaps ten times as much stone is covered up as can be seen, and likewise as a clue to many other special things that may have been done. A complete investigation should then be made of the situation.

For main track, show the length, weight and brand of rail and (when available) the date of rolling. Classify rail as "first class," "good" or "fair" with reference to the density of traffic and speed of trains. Notes should be taken of crossing frogs, stating whether alloy steel is used. Main-track switches are to be included, but siding and spur-track switches (and crossovers on double track) are shown in the "Siding" notes. The notes on fastenings include form of joint, length of splice bars, number of bolts, tie-plates, rail braces, etc.

For ties, the notes must show the kind of tie and number per rail, also pluses for the beginning and ending of each kind of tie; also the general condition and the percentage of ties renewed each year. Note the position and length of space occupied by bridges, switches or railway crossings, so that allowance may be made in computing ties. For each bridge (except with ballasted floor) show the number and size of ties and feet board measure.

TRESTLES. Division NORTHERN IOWA Bridge No. 1035 File No. 6-21 14

Station EAGLE GROVE Year Reported 1907-15 Date Comp. May 1915 Order No. GMO.12768
Sub-Division 10 Vol and Page 1-22 4-35 Date Insp. 7-11-15 Est. No.
Section 32 Map Corrected 9-15

Remarks

Location	Type	DATE Super St	DATE Sub St	Total Length	Span Length	No. of Spans	Grade + or −	Alignment	No. of Tracks
1735-22	Pile Bridge	1915	1915	65'	13'	5	-.51	Tang.	1

STRINGERS Kind	No.	Dimensions	TIES No.	Kind	Size	GUARD RAILS No.	Kind	Size	FLOORING Kind	Amt	CAPS Size	Kind
Fir	6	8"x 16"	62	Fir	8"x 8"-10'	2		4"x 10"	65 Lin.ft Floor & Hand Rail		14"x14"-	14'

PILE BENTS No. Bents	In This Each	Avg Height	PILING Lin Ft	PILING Kind	FRAME BENTS No. Bents	No. Posts Each	Size of Posts	Alg. Ht Bents	Size of Sills	Total Ft B.M Framing	Cu. Yds Masonry
4	5	15'	540	Cedar	2	5	12"x 12"	12'	14"x14"-14'	1983	
									Sway Bracing =	577 Ft. B.M.	

WATER STATIONS. Division EASTERN File No. 5-25 28 -1

Station YORK Year Reported 1909-10-14 Date Compl. 1913 Order No. GMO 11671
Sub-Division 8 Vol. and Page 2-67 to 69 Date Insp. 7-11-14 Est. No.
Section 15 Map Corrected 1915 Total Cost $4376.00

Remarks:

TANK Dimensions	Matrl.	Capacity	No. of Spans	SUPPORTS Kind	Ht.	No. Posts	Size Posts	FOUNDATION Kind	Amount	WATER SUPPLY Type	Dimensions
16'x 24'	Wood	48606	1	Steel	16'	4		Masonry	70 Cy.	Well	8"x 40'

ENGINE Kind	Capacity	PUMP Kind	Size	WINDMILL Kind	Diam	Make	TOWER Kind	Ht.	BOILER Dimn.	Type	Size and Length Piping
F.M.& Co.		U.S.W.E.	4x12	Wood	20'	U.S.	Wood	50'			758'of 2'
Jack of	4 H.P.	Myers	Bulldozer								8'of 3"
all Trades		8" Head									

PUMP HOUSE Kind	Dimn.	Kind Floor	Kind Roof	PENSTOCKS Size	Make	Length and Size Supply Pipe
Frame	6'x 8'	Concrete				
Height to E. = 6'			Shingle		1 Standard Hog	Pump Pit 8'x 12'
Height to G. = 8'					Sprinkler	Brick Lined

CARD-INDEX RECORDS FOR VALUATION; CHICAGO & NORTHWESTERN RY.

Each card is 5x8 in. The upper card gives the record of a trestle and the lower card gives the record of a water station